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# USAAVLABS TECHNICAL REPORT 70-1B

# HELICOPTER ROTOR ROTATIONAL NOISE PREDICTION AND CORRELATION

## VOLUME II

## DOCUMENTATION OF NOISE PREDICTION COMPUTER PROGRAM

By

Ronald G. Schlegel

William E. Bausch

November 1970



## U. S. ARMY AVIATION MATERIEL LABORATORIES
## FORT EUSTIS, VIRGINIA

CONTRACT DA 44-177-AMC-448(T)
SIKORSKY AIRCRAFT
DIVISION OF UNITED AIRCRAFT CORPORATION
STRATFORD, CONNECTICUT



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This contract was initiated to acquire NH-3A/S-61F helicopter noise measurements simultaneously with low- and high-frequency aerodynamic rotor loads for the purpose of verifying the accuracy of a rotational noise prediction program. The program itself was modified from the previously assumed rectangular chordal airload distribution to the actual measured chordal airload distribution or to any arbitrary chordal distribution that the program user wished to assume.

Results of this contract demonstrate the importance of high-frequency airloads and the chordal airload distribution in rotational noise predictions. Although inconclusive regarding how many loading harmonics are necessary, findings do show that knowledge of the chordal airload distribution can compensate for a lack of high-frequency airload data.

There are a few available analytical solutions to helicopter rotational noise in addition to that reported herein. These analyses vary in rigor of approach, degree of difficulty of usage, and quantity of input data required, but all appear to be uniformly accurate for the first three or four harmonics of rotational noise under the few normal rotor operating conditions examined.

A program is currently under way to: (1) simultaneously acquire noise and rotor airloads data for "slapping" and "nonslapping" flight conditions of a CH-53A helicopter and (2) correlate these data with noise and airloads prediction methods. The acoustic analyses presented herein will be modified and used in an attempt to predict the occurrence of impulsive rotor noise.

Task 1F162203A14801
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# HELICOPTER ROTOR ROTATIONAL NOISE PREDICTION AND CORRELATION

Final Report

Volume II

## DOCUMENTATION OF NOISE PREDICTION COMPUTER PROGRAM

By

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Prepared by

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Stratford Connecticut

For

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FORT EUSTIS, VIRGINIA

## ABSTRACT

A computer program for rotational noise prediction is documented in the following sections of this report. The program was developed as a part of a study to develop more accurate methods for predicting rotational noise levels under conditions of nonuniform inflow over the rotor disc.

The computer program will calculate the root-mean-square sound pressure level for up to the 10th harmonic of rotor noise at any field point in the near or far field outside of the rotor disc. Noise levels can be calculated either from a rectangular chordwise distribution of pressure or from the measured chordwise distribution. The equations for noise prediction using the arbitrary (measured) chordwise distribution are derived in Volume I of this report. Although this report concentrated on a helicopter rotor, the analytical results are applicable to propellers in general.

# FOREWORD

A computer program for rotational noise prediction was written by Sikorsky Aircraft, Division of United Aircraft Corporation, as part of Contract DA 44-177-AMC-448(T), Task 1F162203A14801. USAAVLABS Project Engineer was Mr. Joseph H. McGarvey.

Acknowledgement is made to Mr. Gediminias Campe for his help in designing the computer program and in bringing it to operational status.

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## INTRODUCTION

This report describes a computer program for calculating noise harmonic levels of rotor (or propeller) rotational noise at any point in the acoustic near or far field. In order to simplify the analysis, noise due to blade thickness and aerodynamic shears is not considered, and the rotor disc is assumed to be a flat circular plate perpendicular to the thrust of the rotor system.

The basic physics of the noise prediction analysis are straightforward. Acoustic dipoles (sources and sinks) are the mathematical models used to describe the pressure variations caused by a rotor blade passing over any given point in the rotor disc. By applying an acoustic wave equation, the pressure variations at this point in the disc are transformed to a rotational noise component at a particular field point or observer location. In order to calculate the net rotational noise for a given harmonic and field point, the contributions of many points in the rotor disc are added (vector addition with magnitude and phase) to produce the root-mean-square sound pressure level (SPL) in decibels (dB).

The form of the pressure pulse seen by a point in the rotor disc is important in determining how much noise will be generated. The noise prediction program is designed to use a pulse of arbitrary form, namely the measured chordwise distribution of differential pressure on the section of rotor blade that passes over the point of interest in the rotor disc.

## PROGRAMMER/USER INFORMATION

### HARDWARE AND SOFTWARE REQUIREMENTS

The noise prediction computer program is written in FORTRAN V for a UNIVAC 1108 digital computing system. In order to manipulate all of the data generated by the program, direct-access storage devices are used. These devices should be UNIVAC FH-332 drums, each with a capacity of at least 90,000 words. Three drum units are called by the program.

### PROGRAM DESCRIPTION

The following sections of this report describe the subroutines, structure, and running of the noise prediction computer program.

#### Subroutines

The name and function of each of the program subroutines are listed below. During normal operation, i.e.,all input data on punched cards, the subroutines dealing with magnetic tape will not be called by the main program

E676 Main program, calculates SPL based on the actual chordwise distribution of pressure.

BLODAT BLOCK DATA subroutine.

RDKU Reads in one record from the proper input tape, where two records make up one azimuthal pressure cycle.

UNPACK Unpacks an array containing tape information (two records) into separate arrays representing azimuthal pressure cycles for each pressure transducer channel.

INTERP Linearly interpolates pressure pulse harmonics up to 20 blade span stations and 288 azimuths.

CUE Calculates an array which is a function of azimuth and blade station. A double integration of this variable yields the sound pressure components Um and Vm.

INPUTA Reads and prints out card input.

MERGES Combines the absolute pressure of the instrumented top and bottom blade stations, to produce only differential pressures for all blade stations.

OUTSPL Output subroutine.

DFSRIE Computes the coefficients of a Fourier series.

AVQUAD Performs integration by averaged quadratics based on Lagrange interpolation.

E386RN Calculates SPL based on a rectangular chordwise distribution of pressure.

SIMCOR Simpson's Rule integration subroutine.

CURVIT Cubic interpolation subroutine.

PARAM Subroutine used by CURVIT.

CUBIC Subroutine used by CURVIT.

TRIDAG Subroutine used by CURVIT.

START Initializes the clock subroutine CLOCK.

CLOCK Calls the computer clock for the time.

Overlay Structure

In order to pack the data and processing instructions into the memory of the UNIVAC 1108, an overlay technique was used. The overlay map is given below. The small "b" indicates a blank space on the punched card.

```
bbMAPbE676,,OVER

bbbbbbbSEGbE676-(*E386RN,*ALPHA)

ALPHAbbSEGb*RDKU-*UNPACK-*INTERP-*CUE-*INPUTA-*MERGES-*OUTSPL-*DFSRIE

7/8bABSbOVER,AE676

7/8bXQTbCUR
```

Program Symbols

Both the definition of the alpha-numeric symbols and their proper input units are indicated below. These symbols are used in the programmed equations and in the sample input that are presented later in this report. During normal operation, only those symbols under CARD INPUT need to be included in the input data set.

| TAPE INPUT | CARD INPUT | PROGRAM SYMBOL | UNITS | DESCRIPTION |
|---|---|---|---|---|
| XX | X | BB | in. | Blade thickness; floating point |
| XX | X | AA | in. | Blade chord; floating point |
| XX | X | BLADEL | in. | Length of blade (root to tip); floating point |

| TAPE INPUT | CARD INPUT | PROGRAM SYMBOL | UNITS | DESCRIPTION |
|---|---|---|---|---|
| XX | X | GAMA | deg/in. | Twist rate of main rotor blade; floating point |
| XX | X | RO | in. | Radial station with zero twist; floating point |
| XX | X | CC | in./sec | Speed of sound; floating point |
| XX | X | OMEG | rpm | Rotor rotational speed; floating point |
| XX | X | DPSI | deg | Delta azimuth angle=$1.25^{\circ}$ or a multiple of $2.5^{\circ}$. All calculations are done at this increment |
| XX | X | NBLADE | | Number of main rotor blades; fixed point |
| XX | X | MLIMDP | | Highest order of harmonic desired to represent all pressure cycles (=1 to 30); fixed point |
| XX | X | MLIMRN | | Highest order of harmonic desired in the rotor noise calculations (=1 to 10); fixed point |
| XX | X | LSPAN | | The number of radial stations as a result of interpolation (=10 or 20). This is an option |
| XX | X | IREELS | | Total number of reels (up to 5) |
| XX | X | TCOP | | =TAPE, data will be read from tape<br>=CARD, data will be read from cards |
| XX | X | PUNCH | | =YES (option to punch out pressure cycle coefficients) |
| XX | X | INTERM | | Intermediate output to be used for checkout; =YES or = NO |
| XX | X | IDD | | Debug printout option; = 0, do not print; =1, print |
| XX | X | E3860P | | =YES, call rotor noise subroutine E386RN<br>=NO, do not call E386RN |

| TAPE INPUT | CARD INPUT | PROGRAM SYMBOL | UNITS | DESCRIPTION |
|---|---|---|---|---|
| XX | X | OPRONO | | Option to calculate SPL from actual chordwise loading =YES, perform rotor noise program =NO, go to subroutine E386RN |
| XX | X | NFT | | Number of field points (up to 20); fixed point |
| XX | X | ANG | deg | Increment of integration used in E386 subroutine; floating point |
| XX | X | NHH | | Number of Air Load harmonics for E386 program (up to 30); fixed point |
| XX<br>XX<br>XX | X<br>X<br>X | KEY1<br>KEY2<br>KEY3 | | =99, have intermediate output from the E386 program =00, no intermediate output |
| XX<br>XX<br>XX | X<br>X<br>X | CAPRF(I)<br>THETAF(I)<br>ALFAF(I) | ft<br>deg<br>deg | Spherical coordinates of field point I, used in subroutine E386RN; floating point |
| XX<br>XX<br>XX | X<br>X<br>X | XFP(I)<br>YFP(I)<br>ZFP(I) | in.<br>in.<br>in. | Coordinates of field point I, origin being at center of rotor disc (I=variable= 1 to 20); floating point |
| XX | X | IBURST | | Burst number being processed, identifies data on telemetry tape |
| | X | BO | deg | Collective pitch angle; floating point |
| | X | BIC | deg | Longitudinal cyclic pitch; floating point |
| | X | BIS | deg | Lateral cyclic pitch; floating point |
| | X | IN | | Spanwise station number, fixed point |
| | X | JN | | Chordwise station number, fixed point |
| | X<br>X | CN(I,JN,IN)<br>SN(I,JN,IN) | psi<br>psi | Fourier coefficients of differential pressure where: I = harmonic, JN= chord, IN= span |

| TAPE INPUT | CARD INPUT | PROGRAM SYMBOL | UNITS | DESCRIPTION |
|---|---|---|---|---|
| XX | | SLOPE(I,K) | psi / full scale | Conversion factors used to get the tape data into engineering units for each tape parameter. I = channel number, K = reel number |
| XX | | OFFSET(I,K) | psi / full scale | |
| XX | | KUNIT(I) | | Tape drive units on which to mount tape reels |
| XX | | IREEL | | Input tape reel number |
| XX | | NC | | Channel number |
| XX | | NTBDX(I,J) | | Designates top or bottom pressure gage I = IREEL, J = NC |
| XX | | NSTATC(I,J) | | Relative chordal position of pressure gage from leading edge (=1,2,3,4,5). I=IREEL, J = NC |
| XX | | NSTATR(I,J) | | Relative radial station measured from root of blade (=1,2,3,4,5) I = IREEL, J = NC |
| XX | | NCEND | | Input control word. When NCEND is not blank, card specifying reel number follows |
| XX | | ISET(I) | | Set number for reel IREEL |
| XX | | FROC(K) | | Filter roll-off correction curve, where K represents the order of the loading harmonic (K= 1 to 30) |
| | | Q1(288,20)<br>Q2(288,20)<br>Q3(288,20) | | Functions used in the double integration |
| | | UMF(10,20)<br>VMF(10,20) | | Components of sound pressure |
| | | PMRMS(10,20) | | Sound pressure |
| | | SPLM(10,20) | | Sound pressure level |
| | | LAZI | | The number of azimuth stations as a result of interpolation This is calculated knowing DPSI |

| TAPE INPUT | CARD INPUT | PROGRAM SYMBOL | UNITS | DESCRIPTION |
|---|---|---|---|---|
| | | IRS(I) | | Instrumented radial station counter, counting from blade root. If station N.G. then IRS(I) = 0 |
| | | ITRACK(I) | | Track number for reel number I |
| | | FI(I,J) | | Gaussian integration factors for radial station I, chord station J |
| | | NCHAN(I,L) | | Blade instrumented station designation for radial station I, chord station J. If = 0, then that station is N.G. |
| | | RR(I) | fraction | Fractional radial station measured from hub center. I = span station = 1 to 5 |
| | | XA(I,J) | fraction | Fraction of distance along chord from leading edge. J = span = 1 to 5, I = chord station = 1 to 5 |
| | | NCH(I) | | Total number of chord stations for radial position I |
| | | XLO(I)<br>XLM(I,J)<br>XMM(I,J) | lb/in.<br>lb/in.<br>lb/in. | Air Load harmonics used in subroutine E386 where: I = radial station and J = harmonic |
| | | CHORD(I) | fraction | Chord station array used in the average quadratics integration to get Air Loads (I = chord) |
| | | GPSI(I) | psi | Differential pressure array along a chord, used in average quadratics integration |
| | | FN(I) | | Temporary array used to store Air Loads just before harmonic analysis |
| | | PI | rad | PI = 3.14159 |
| | | AZMTH2(I) | rad | Azimuth array 0 to $2\pi$ rad in $(2.5\pi/180)$ rad increments (I = 1 to 144) |
| | | AZMTH(I) | deg | Azimuth array 0 to 360 deg in 2.5-degree increments (I = 1 to 144) |

| TAPE INPUT | CARD INPUT | PROGRAM SYMBOL | UNITS | DESCRIPTION |
|---|---|---|---|---|
| | | AZMTH3(288) | | Azimuth array every DPRAD radians from 0 to $2\pi$ |
| | | DPRAD | rad | $\Delta\psi$ expressed in radians |
| | | BLADES | | Number of blades |
| | | SPAN(L) | in. | Radial stations used in the double integration, L = 1 to 20 |
| | | S | in. | Distance from element of rotor disc to field point |
| | | B | deg | Blade pitch angle |
| | | GPSI1(I) | psi | Array used in integration of $g_m(\psi,R)$ and $h_m(\psi,R)$ |
| | | CHORD2(I) | fraction | Interpolated chord station array used in integration of $g_m(\psi,R)$ and $h_m(\psi,R)$ |
| | | AN(I,J,K)<br>BN(I,J,K) | | Cosine and sine Fourier coefficients used in filter roll-off correction. I = harmonic, J = channel, K = reel |
| | | TEM1(I)<br>TEM2(I) | | Temporary arrays used in Fourier analysis subroutine arguments |
| | | AZRAD | rad | $2.5^{\circ}$ expressed in radians |
| | | ICHANL(I,J) | | Tape channel designation, where J = 1 to NOCH(J) and I = 1 to IREELS |
| | | NO<br>YES | | Control words used to check whether or not to execute an option |
| | | NBLANK | | Word with all blanks in it |
| | | TEE | | Equals "T" in Hollerith used to designate top of blade |
| | | BEE | | Equals "B" in Hollerith used to designate bottom of blade |
| | | DEE | | Equals "D" in Hollerith used to designate differential pressure |

| TAPE INPUT | CARD INPUT | PROGRAM SYMBOL | UNITS | DESCRIPTION |
|---|---|---|---|---|
| | | COSINE(I) | deg | Cosine array defined every DPSI degrees |
| | | SINE(I) | deg | Sine array defined every DPSI degrees |
| | | AZ41(I) | rad | Azimuth points I along the chord for a given nominal azimuth |
| | | NCYCLE | | Cycles in a burst, counter |
| | | CYCLES | | Total number of cycles in a burst |
| | | KU | | Current tape unit number |
| | | NDIV(4) | | Used to shift integer numbers |
| | | BMASK(6) | | Used to mask out parts of a word |
| | | NOCH(I) | | Total number of good channels on reel number I |
| | | LIRS | | Number of good radial stations |
| | | FTRACK | | Current track numbers being read from tape (2nd half of NN(217)) |
| | | FBURST | | Current burst number being read from tape (2nd half of NN(218)) |
| | | FREC | | Current record number being read from tape (2nd half of NN(219)) |
| | | NN(435) | | Tape data cycle array made up of 2 records (Last 3 words are control words) |
| | | ND1(I,J,K)<br>ND2(I,J,K) | | Unpacked raw data arrays where: I = azimuthal data point, J = chord station, K = radial station |
| | | DATA2(I,J,K) | | Unpacked average raw data cycle where:I = data point, J = chord station, K = radial station |
| | | DATA1(I,J,K) | psi | Scaled and corrected average pressure cycles where: I = data point, J = chord, K = radial station |

| TAPE INPUT | CARD INPUT | PROGRAM SYMBOL | UNITS | DESCRIPTION |
|---|---|---|---|---|
| | | COSRN(I)<br>SINRN(I) | | Cosine and sine arrays, the elements being calculated at each instrumented chord station. Used in calculating Fourier coefficients of acoustic Air Loads |
| | | GPSI2(I) | psi | Differential pressure array along a chord, used in average quadratics integration |
| | | GMAR(I,K) | | mth cosine coefficient of acoustic pressure pulse where K = radial station, I = azimuthal station |
| | | HMAR(I,K) | | mth sine coefficient of acoustic pressure pulse where K = radial station, I = azimuthal station |
| | | DPSI1(I) | psi | Differential pressure array along chord, used in averaged quadratics integration |
| | | GMARI(I,K) | | mth cosine coefficient of acoustic pressure pulse after interpolation. I = up to 288, K = 10 or 20 |
| | | HMARI(I,K) | | mth sine coefficient of acoustic pressure pulse after interpolation. I = up to 288, K = 10 or 20 |
| | | TEMP1(I)<br>TEMP2(I)<br>TEMP3(I) | | Temporary work arrays used in the interpolation of GMAR and HMAR |
| | | XO(I)<br>YO(I) | | Arrays used in interpolation, I = 1 to 20 |
| | | W(I) | | Temporary work array, I = 1,14 |
| | | NOPTS1 | | Number of radial stations before interpolation (including end points .194 and 1.0)(up to 7) |
| | | ISI | | ISI = (DPSI/2.5) $\geq$ 1; if $\leq$ 0 then ISI = 1 |
| | | POINT(15) | | Gauss integration points (normalized) |

| TAPE INPUT | CARD INPUT | PROGRAM SYMBOL | UNITS | DESCRIPTION |
|---|---|---|---|---|
| | | WPOINT(15) | | Gauss integration weights |
| | | NXY | | Number of Gauss points and weights to be used |
| | | PI2 | rad | PI2 = 6.28318 |
| | | IX | | The number of radial intervals to be used in the double integration |
| | | IY | | The number of azimuthal intervals to be used in the double integration |

## Input/Output

The input format is defined symbolically in Figure 1. Note that the blank lines are used to insure legibility. Normal input data would have no blank lines (unpunched cards) unless all of the parameters on a particular card happen to be equal to zero. Figure 2 is a sample numerical input for the first span station with 8 harmonics of pressure for each chord station. The format for the pressure harmonics CN(I,J,K) and SN(I,J,K) for the remaining span stations is completely analogous to that for Span 1. Span stations are specified from root to tip of the blade, and chord stations are specified from leading edge to trailing edge.

Normal output from the noise prediction program contains the following information:

1. Listing of the input parameters except the harmonics of pressure.
2. Values of differential pressure at each span and chord station every DPSI degrees of azimuth from the sum of the input pressure harmonics.
3. Field point coordinates and the corresponding predicted SPL for each noise harmonic.

A typical output is contained in Figure 3.

## Operating Instructions

The noise prediction computer program has several options that may be selected. For normal operation, the print options for INTERM and IDD should be refused. If this is not done, several hundred pages of non-essential output will be generated. The following suggestions assume that the input pressure data are on punched cards so that option TCOP is equal to CARD (i.e., no data on magnetic tape).

The azimuthal increment of integration for E676 can be varied from 1.25 degrees to integral multiples of 2.5 degrees, while the value of ANG used in subroutine E386RN can be any value greater than 0.5 degree as long as

(360/ANG) is an even integer. Normally, DPSI and ANG should be equal. If only the first harmonic of noise is being calculated, an increment of 10.0 degrees is acceptable. If 4 harmonics of noise are desired, an increment of 2.5 degrees is recommended. The number of interpolated span stations can be 10 or 20. The larger is recommended for DPSI of 2.5 degrees or less.

Results presented in Volume I of this report demonstrate the importance of high-frequency loading harmonics for prediction of the higher harmonics of noise. At least 15 loading harmonics are recommended for calculation of up to the fourth noise harmonic. However, if only the level of the fundamental is desired, 2 or 3 loading harmonics probably will suffice.

Running time will be a function of the angular increment selected. Calculation of 4 harmonics of rotor noise at 20 field points from both the actual and the hypothetical rectangular chordwise pressure distributions requires approximately 6 minutes of machine time (excluding time for CUR instructions and compilation which can be on the order of 1 minute). Calculations with the actual chordwise distribution take roughly 5 minutes while the corresponding calculations with the rectangular distribution require approximately 1 minute. Running time increases as the azimuthal increment becomes smaller.

The coordinate system for E676 is right-handed Cartesian with Z positive up (in direction of rotor thrust), X positive aft, and Y positive to starboard. The origin of the system is at the center of rotation of the rotor. The coordinate system for E386RN is spherical in which R is the distance between the center of rotation and the field point, $\theta$ is the azimuth angle in the plane of the rotor disc, and $\sigma$ is the elevation angle relative to the rotor disc (positive for field points above the disc). Figure 4 contains the coordinate systems for OPRONO and E3860P as used for a conventional helicopter rotor.

If the noise prediction program is used to calculate rotational noise for a propeller rather than a rotor, the following coordinate system definition applies. Z and $\sigma$ are positive for field points on the positive thrust side of the rotor disc. The X-axis and $\theta$ = zero line coincide with the reference point for the azimuthal loading harmonics.

It is advisable to calculate rotational noise via both the OPRONO and E3860P options to determine if the loading details included in OPRONO need to be considered for the configuration being studied. If the rectangular chordwise loading distribution yields acceptable results, use E386 exclusively in order to save computing time.

Detailed instructions regarding control cards and execution commands must be provided by a programmer who is familiar with the particular UNIVAC 1108 installation that is to be used. When the input data and overlay structure are specified correctly, no problems should be encountered in running the program.

## Program Logic

Program E676 proceeds as follows for card input (TCOP = CARD):

1. Accept harmonics of differential pressure from cards. Sum these harmonics to produce the differential pressure at each span and chord station every DPSI degrees of azimuth.
2. If output from E386 is desired, calculate the blade section loading (pounds per inch of span) by integrating the differential pressures across the chord at each span station. A trapezoidal integration routine is used.
3. Proceed through E386.
4. If noise levels based on the actual chordwise pressure distribution are required, interpolate to provide 41 points along the blade chord. These points are required to define the Fourier coefficients of the pulse shape (chordwise pressure distribution).
5. Calculate GMAR and HMAR for a particular noise harmonic.
6. Interpolate GMAR and HMAR if 288 azimuthal points and 20 radial points are desired. This interpolation produces GMARI and HMARI.
7. Calculate CUE array for the first field point.
8. Calculate UMF and VMF components of sound pressure for the first field point.
9. Calculate SPLM for the first field point.
10. Repeat steps 7, 8, and 9 for the rest of the field points (field point loop).
11. Repeat steps 5 through 10 for the rest of the noise harmonics (harmonic loop).
12. Repeat steps 1 through 11 for the remaining flight conditions or "data bursts" (burst loop).

## Program Equations

Volume I of this report contains the derivation of the noise prediction equations. The critical parameters are GMARI, HMARI, S, Q1, Q2, Q3, UMF, VMF, PMRMS, and SPLM. The relationship between these program symbols and their engineering counterparts is:

GMARI = $g_m$

HMARI = $h_m$

S = s

Q1 = $rq_1$

Q2 = $Q1q_2$

Q3 = $Q1q_3$

UMF = $U_m$

VMF = $V_m$

PMRMS = $P_m$

SPLM = $SPL_m$

UMF
$$u_m = \frac{1}{4\pi}\int_0^{2\pi}\int_0^{r_t} b\, q_1 q_2\, r\, dr\, d\psi$$

VMF
$$v_m = \frac{1}{4\pi}\int_0^{2\pi}\int_0^{r_t} b\, q_1 q_3\, r\, dr\, d\psi$$

Q
$$q_1 \equiv (x - r\cos\psi)\sin\beta\,\sin\psi - (y - r\sin\psi)\sin\beta\,\cos\psi + z\cos\beta$$

$$q_2 \equiv g_m\left(\frac{-\cos\phi}{s^3} - \frac{mn\Omega}{cs^2}\sin\phi\right) + h_m\left(\frac{\sin\phi}{s^3} - \frac{mn\Omega}{cs^2}\cos\phi\right)$$

$$q_3 \equiv g_m\left(\frac{-\sin\phi}{s^3} + \frac{mn\Omega}{cs^2}\cos\phi\right) + h_m\left(\frac{-\cos\phi}{s^3} - \frac{mn\Omega}{cs^2}\sin\phi\right)$$

$$\phi = mn\Omega\left(\frac{\psi}{\Omega} + \frac{s}{c}\right)$$

GMAR
$$\vec{g_m}(r,\psi) = \frac{n}{\pi b}\int_{-a/2r}^{a/2r} \vec{l}(r,\psi)\cos mn\psi\, d\psi$$

HMAR
$$\vec{h_m}(r,\psi) = \frac{n}{\pi b}\int_{-a/2r}^{a/2r} \vec{l}(r,\psi)\sin mn\psi\, d\psi$$

S $$s=\left[(x-r\cos\psi)^2+(y-r\sin\psi)^2+z^2\right]^{\frac{1}{2}}$$

Program Listing

The listing for the complete noise prediction deck is contained in Figures 5 through 38. Figure titles correspond to the program or subroutine contained in the figure.

Limitations of the Program

Some aspects of the rotational noise prediction program limit its immediate operation by new users. The direct-access storage drums are called 28, 29, and 30 by the program and the NTRAN routine. It probably will be necessary to change these call numbers to match those used on the UNIVAC 1108 system.

Some additional changes will be required in the programmed equations if the rotor blades being studied differ from those of the NH-3A described in Volume I of this report. In particular, the span stations for which input pressure data are available are assumed to be 40%, 75%, 85%, 95%, and 98% of the radius (BLADEL). The program further assumes that the input chord stations or transducer locations are at 4.2%, 15.8%, 30%, 60%, and 91% chord (AA). In addition, the lifting surface of the blade is assumed to consist of the outer 80.1% of span. Changes in the chord locations will affect the interpolation routine used to calculate GMAR and HMAR, while changes to the span will affect the interpolation used to calculate GMARI and HMARI. These changes are not difficult to make once the programmer is familiar with the deck.

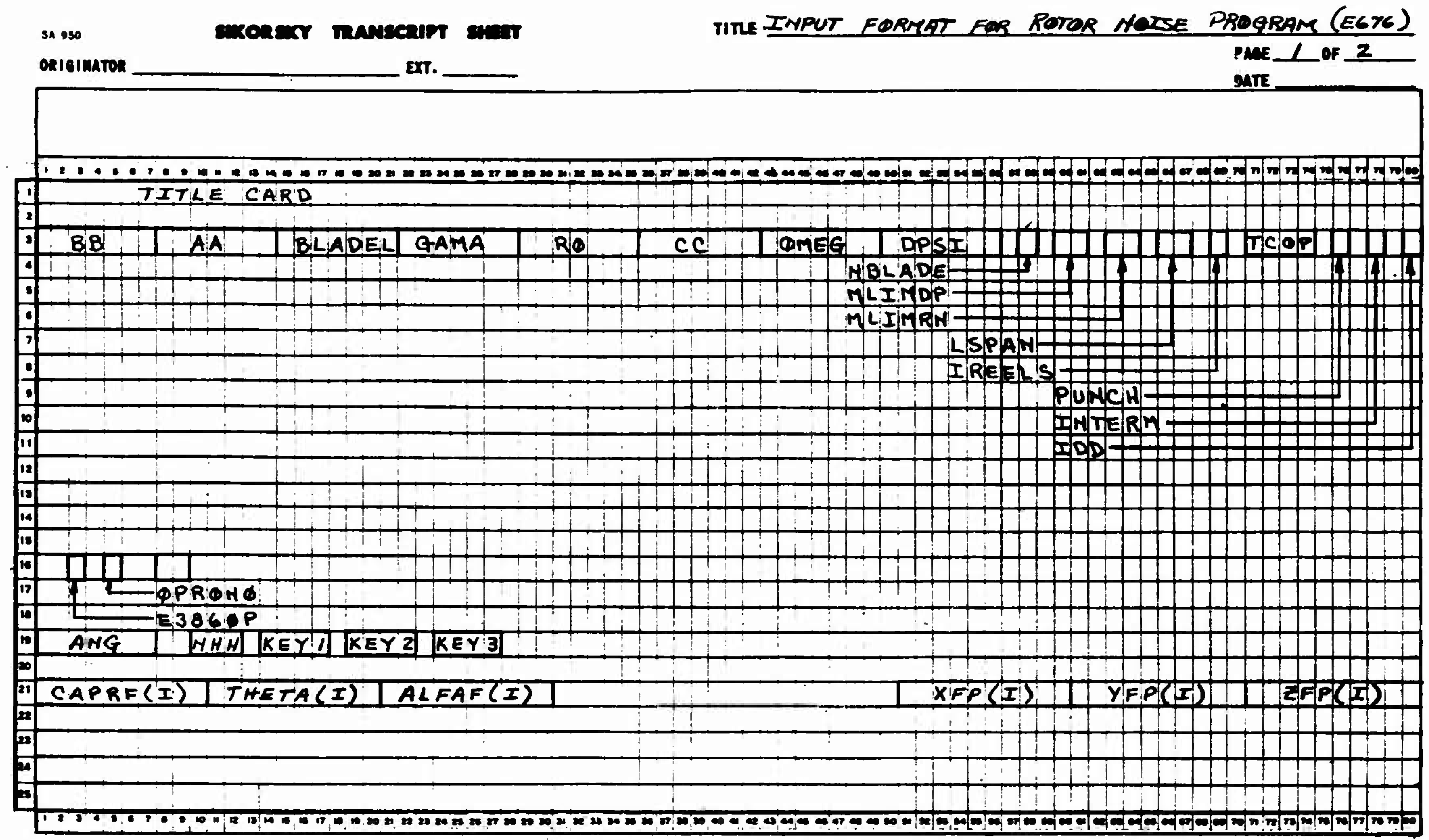



Figure 1. Sample Input, Symbolic.

SA 950 **SIKORSKY TRANSCRIPT SHEET** TITLE INPUT FORMAT FOR ROTOR NOISE PROGRAM (E676)

ORIGINATOR ______ EXT. ______ PAGE 2 OF 2

DATE ______

```
BURST NO. =IBURST         *** ROTOR NOISE PUNCHED OUTPUT ***

BLADE PITCH HARMONICS

                          (COLLECTIVE, LONGITUDINAL, LATERAL RESPECTIVELY)

DIFFERENTIAL PRESSURE HARMONICS FOR 5 CHORD STATIONS AT EACH OF THE 5 SPANS
(MEASURING FROM THE LEADING EDGE AND THE BLADE ROOT RESPECTIVELY).

       IN          JN
SPAN      CHORD          STEADY=  CH(1,JN,IN)

COSINE COEFFICIENTS

CN(2,JN,IN) CN(3,JN,IN)  ...

SINE COEFFICIENTS

SN(1,JN,IN) SN(2,JN,IN)  ...
```

Figure 1. Sample Input, Symbolic - Concluded.

SA 950 **SIKORSKY TRANSCRIPT SHEET** TITLE *SAMPLE INPUT*

ORIGINATOR ________ EXT. ______ PAGE 1 OF 3

DATE ________

```
S-61F 16SKT LOW WING LOADING-8HARMONICS L(R, PSI)

 2.0    18.2  372.0 0.0134   72.0  13040.0 204.0  2.5   5   8   4 20  0 CARD N N 0
 Y Y  10
  2.5   4  00  00  00
1545.0   169.9    -23.20                        -16800.0  3000.0   -7320.0
1197.0   166.0    -30.33                        -12000.0  3000.0   -7296.0
1114.0   164.5    -33.07                        -10800.0  3000.0   -7296.0
1035.0   162.2    -35.97                         -9600.0  3000.0   -7296.0
 960.0   160.3    -39.28                         -8400.0  3000.0   -7296.0
 890.0   157.3    -43.08                         -7200.0  3000.0   -7296.0
 826.0   153.4    -47.40                         -6000.0  3000.0   -7296.0
 769.0   148.0    -52.18                         -4800.0  3000.0   -7296.0
 723.0   140.2    -57.28                         -3600.0  3000.0   -7296.0
 687.0   128.7    -62.23                         -2400.0  3000.0   -7296.0
```

Figure 2. Sample Input, Numeric.

SA 950 **SIKORSKY TRANSCRIPT SHEET** TITLE SAMPLE INPUT

ORIGINATOR ________ EXT. ______ PAGE 2 OF 3

DATE ______

```
BURST NO.=13     *** ROTOR NOISE PUNCHED OUTPUT ***
BLADE PITCH HARMONICS
0.5150    1.7878    9.1546     (COLLECTIVE, LONGITUDINAL, LATERAL RESPECTIVELY)
DIFFERENTIAL PRESSURE HARMONICS FOR 5 CHORD STATIONS AT EACH OF 5 SPANS
(MEASURING FROM THE LEADING EDGE AND THE BLADE ROOT RESPECTIVELY)
SPAN 1   CHORD 1            STEADY=1.0363+00
COSINE COEFFICIENTS
-9.8263-01 5.9133-01 2.4036-01-1.1329-01-1.0611-01-5.3502-02 1.0455-02-7.4505-03
SINE COEFFICIENTS
 7.7656-01-6.8249-01 5.7926-01 2.5240-01 1.2384-01 2.5328-02 4.5821-02-1.0433-02
SPAN 1   CHORD 2            STEADY=5.7707-01
COSINE COEFFICIENTS
-4.8362-01 2.6994-01 1.3409-01-5.6017-02-7.3457-02-2.3293-02 7.8033-03-7.2251-03
SINE COEFFICIENTS
 5.1175-01-3.7734-01 2.2282-01 1.3558-01 5.6567-02 9.7851-03 2.8522-02-1.2267-02
SPAN 1   CHORD 3            STEADY=2.3444-01
COSINE COEFFICIENTS
-3.6099-01 1.7189-01 4.9981-02-2.3969-02-5.2198-02-1.2333-02-5.7960-04-2.1508-03
SINE COEFFICIENTS
 2.6526-01-3.0031-01 9.3589-02 5.8273-02 2.8389-02 1.3377-02 1.3645-02-1.0780-02
SPAN 1   CHORD 4            STEADY=-4.9016-02
COSINE COEFFICIENTS
-1.1094-01 8.3637-02 1.9119-02-8.1379-03-1.9951-02 7.0415-04-3.1862-03 1.9911-03
SINE COEFFICIENTS
 3.5763-02-1.2231-01 2.6333-02 2.9186-02 1.0332-02-4.3339-03 8.9812-04-6.2971-03
```

Figure 2. Sample Input, Numeric - Continued.

SA 950 **SIKORSKY TRANSCRIPT SHEET** TITLE SAMPLE INPUT

ORIGINATOR ____ EXT. ____ PAGE 3 OF 3

DATE ____

```
SPAN 1   CHORD 5         STEADY=-4.7925-02
COSINE COEFFICIENTS
-6.9048-03 1.9961-02-1.8405-03-1.1350-02 3.8156-03 1.0718-02-1.5727-03 5.5342-04
SINE COEFFICIENTS
 8.3695-02-3.3696-02-1.1692-02 4.1600-03 1.2237-02-8.4147-04-5.0161-03-4.3599-03
```

Figure 2. Sample Input, Numeric - Concluded.

```
S-61F I65KT LOW WING LOADING - 16 HARMONICS L(R,PSI) 110278?

BLADE THICKNESS (IN)      =  .2000+01     ZERO TWIST BLADE STA.    (IN)     =  .7400+02

BLADE CHORD     (IN)      =  .1820+02     SPEED OF SOUND           (IN/SEC) =  .1304+05
BLADE LENGTH    (IN)      =  .3720+03     ROTOR ROT. SPEED         (RPM)    =  .2040+03
                                          AZIMUTH INCREMENT        (DEG)    =  .2500+01
BLADE TWIST RATE (DEG/IN) =  .1340-01
NUMBER OF BLADES                                  =  5    TAPE / CARD OPTION               = CARD
NO. OF HARMONICS TO REPRESENT PRESSURE CYCLES     = 16    PRESSURE HARMONIC PUNCH OPTION   = N
NO. OF ROTOR NOISE HARMONICS                      =  4    INTERMEDIATE OUTPUT OPTION       = N
NO. OF INTERPOLATED SPAN STATIONS                 = 20
TOTAL NO. OF TAPE REELS                           =  1

OPTION TO USE PROGRAM E386 (THEORETICAL CONST. PRESSURE PULSE)   = Y
OPTION TO USE ROTOR NOISE PROGRAM (MEASURED PRESSURE PULSE)      = Y
NO. OF FIELD POINTS                                              =14

INCR. OF INTEGRATION USED IN E386 (DEG.) =  2.5000    NO. OF AIR LOAD HARMONICS = 16    KEY1= 0  KEY2= 0  KEY3= 0
```

| E386 FIELD POINTS | | | | ROTOR NOISE FIELD POINTS | | | |
|---|---|---|---|---|---|---|---|
| FP | R (FT) | THETA (DEG) | ALPHA (DEG) | FP | X (IN) | Y (IN) | Z (IN) |
| 1 | .1545+04 | .1699+03 | -.2320+02 | 1 | -.1680+05 | .3000+04 | -.7320+04 |
| 2 | .1197+04 | .1660+03 | -.3033+02 | 2 | -.1200+05 | .3000+04 | -.7296+04 |
| 3 | .1114+04 | .1645+03 | -.3307+02 | 3 | -.1080+05 | .3000+04 | -.7296+04 |
| 4 | .1035+04 | .1622+03 | -.3597+02 | 4 | -.9600+04 | .3000+04 | -.7296+04 |
| 5 | .9600+03 | .1603+03 | -.3928+02 | 5 | -.8400+04 | .3000+04 | -.7296+04 |
| 6 | .8900+03 | .1573+03 | -.4308+02 | 6 | -.7200+04 | .3000+04 | -.7296+04 |
| 7 | .8260+03 | .1534+03 | -.4740+02 | 7 | -.6000+04 | .3000+04 | -.7296+04 |
| 8 | .7690+03 | .1480+03 | -.5218+02 | 8 | -.4800+04 | .3000+04 | -.7296+04 |
| 9 | .7230+03 | .1402+03 | -.5728+02 | 9 | -.3600+04 | .3000+04 | -.7296+04 |
| 10 | .6870+03 | .1287+03 | -.6223+02 | 10 | -.2400+04 | .3000+04 | -.7296+04 |
| 11 | .6590+03 | .1218+03 | -.6590+02 | 11 | -.1200+04 | .3000+04 | -.7224+04 |
| 12 | .6820+03 | .5130+02 | -.6200+02 | 12 | .2400+04 | .3000+04 | -.7224+04 |
| 13 | .8220+03 | .2660+02 | -.4710+02 | 13 | .6000+04 | .3000+04 | -.7224+04 |
| 14 | .1031+04 | .1740+02 | -.3570+02 | 14 | .9600+04 | .3000+04 | -.7224+04 |

Figure 3. Sample Output.

DIFFERENTIAL PRESSURE CYCLES AT INSTRUMENTED BLADE STATIONS

SPAN STATION 1 CHORD STATION 1

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6.2306-01 | 8.0127-01 | 9.6152-01 | 1.0958+00 | 1.2034+00 | 1.2879+00 | 1.3535+00 | 1.4021+00 | 1.4317+00 | 1.4383+00 |
| 1.4179+00 | 1.3690+00 | 1.2937+00 | 1.1969+00 | 1.0844+00 | 9.6082-01 | 8.2831-01 | 6.8676-01 | 5.3573-01 | 3.7674-01 |
| 2.1489-01 | 5.8847-02 | -8.0817-02 | -1.9450-01 | -2.7627-01 | -3.2526-01 | -3.4504-01 | -3.4134-01 | -3.1898-01 | -2.7936-01 |
| -2.1981-01 | -1.3488-01 | -1.9212-02 | 1.2926-01 | 3.0724-01 | 5.0610-01 | 7.1393-01 | 9.1915-01 | 1.1141+00 | 1.2970+00 |
| 1.4724+00 | 1.6485+00 | 1.8336+00 | 2.0324+00 | 2.2438+00 | 2.4604+00 | 2.6702+00 | 2.8605+00 | 3.0213+00 | 3.1478+00 |
| 3.2416+00 | 3.3093+00 | 3.3604+00 | 3.4038+00 | 3.4452+00 | 3.4861+00 | 3.5237+00 | 3.5528+00 | 3.5684+00 | 3.5676+00 |
| 3.5512+00 | 3.5226+00 | 3.4866+00 | 3.4466+00 | 3.4019+00 | 3.3471+00 | 3.2724+00 | 3.1670+00 | 3.0229+00 | 2.8391+00 |
| 2.6236+00 | 2.3934+00 | 2.1703+00 | 1.9759+00 | 1.8249+00 | 1.7204+00 | 1.6532+00 | 1.6038+00 | 1.5493+00 | 1.4699+00 |
| 1.3559+00 | 1.2100+00 | 1.0466+00 | 8.8599-01 | 7.4754-01 | 6.4338-01 | 5.7480-01 | 5.3289-01 | 5.0267-01 | 4.6908-01 |
| 4.2243-01 | 3.6126-01 | 2.9177-01 | 2.2436-01 | 1.6891-01 | 1.3090-01 | 1.0985-01 | 1.0043-01 | 9.5579-02 | 8.9921-02 |
| 8.1915-02 | 7.3846-02 | 6.9838-02 | 7.3022-02 | 8.3352-02 | 9.7214-02 | 1.0900-01 | 1.1389-01 | 1.1034-01 | 1.0104-01 |
| 9.1706-02 | 8.8150-02 | 9.3198-02 | 1.0489-01 | 1.1712-01 | 1.2259-01 | 1.1685-01 | 1.0148-01 | 8.4732-02 | 7.8873-02 |
| 9.5111-02 | 1.3807-01 | 2.0224-01 | 2.7227-01 | 3.2738-01 | 3.4842-01 | 3.2509-01 | 2.6025-01 | 1.6958-01 | 7.6530-02 |
| 4.2341-03 | -3.2360-02 | -3.1269-02 | -3.2555-03 | 3.3236-02 | 5.9971-02 | 6.6530-02 | 5.4695-02 | 3.7990-02 | 3.6708-02 |
| 7.0448-02 | 1.5109-01 | 2.7880-01 | 4.4231-01 | | | | | | |

SPAN STATION 1 CHORD STATION 2

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3.5609-01 | 4.3257-01 | 5.0269-01 | 5.6492-01 | 6.1930-01 | 6.6599-01 | 7.0421-01 | 7.3159-01 | 7.4682-01 | 7.4680-01 |
| 7.3176-01 | 7.0358-01 | 6.6579-01 | 6.2225-01 | 5.7587-01 | 5.2760-01 | 4.7642-01 | 4.2024-01 | 3.5734-01 | 2.8781-01 |
| 2.1426-01 | 1.4162-01 | 7.5924-02 | 2.2705-02 | -1.4398-02 | -3.4269-02 | -3.7952-02 | -2.7508-02 | -4.6428-03 | 3.0265-02 |
| 7.8274-02 | 1.4107-01 | 2.1959-01 | 3.1274-01 | 4.1684-01 | 5.2611-01 | 6.3421-01 | 7.3618-01 | 8.3017-01 | 9.1800-01 |
| 1.0045+00 | 1.0956+00 | 1.1956+00 | 1.3056+00 | 1.4220+00 | 1.5372+00 | 1.6418+00 | 1.7271+00 | 1.7878+00 | 1.8235+00 |
| 1.8382+00 | 1.8394+00 | 1.8350+00 | 1.8310+00 | 1.8305+00 | 1.8328+00 | 1.8351+00 | 1.8339+00 | 1.8272+00 | 1.8154+00 |
| 1.8007+00 | 1.7859+00 | 1.7726+00 | 1.7597+00 | 1.7429+00 | 1.7160+00 | 1.6724+00 | 1.6084+00 | 1.5242+00 | 1.4247+00 |
| 1.3186+00 | 1.2155+00 | 1.1236+00 | 1.0467+00 | 9.8398-01 | 9.3056-01 | 8.7974-01 | 8.2573-01 | 7.6584-01 | 7.0127-01 |
| 6.3622-01 | 5.7583-01 | 5.2375-01 | 4.8032-01 | 4.4233-01 | 4.0416-01 | 3.6025-01 | 3.0748-01 | 2.4678-01 | 1.8318-01 |
| 1.2411-01 | 7.6812-02 | 4.5720-02 | 3.0832-02 | 2.7800-02 | 2.9594-02 | 2.9111-02 | 2.1674-02 | 6.4700-03 | -1.3596-02 |
| -3.3477-02 | -4.8280-02 | -5.5295-02 | -5.4939-02 | -5.0286-02 | -4.5475-02 | -4.3769-02 | -4.6135-02 | -5.0991-02 | -5.5169-02 |
| -5.5624-02 | -5.1045-02 | -4.2570-02 | -3.3226-02 | -2.6315-02 | -2.3470-02 | -2.3325-02 | -2.1526-02 | -1.2227-02 | 9.4299-03 |
| 4.4855-02 | 9.0647-02 | 1.3902-01 | 1.8003-01 | 2.0483-01 | 2.0879-01 | 1.9321-01 | 1.6494-01 | 1.3406-01 | 1.1028-01 |
| 9.9669-02 | 1.0271-01 | 1.1450-01 | 1.2703-01 | 1.3253-01 | 1.2675-01 | 1.1075-01 | 9.0767-02 | 7.6141-02 | 7.6175-02 |
| 9.7150-02 | 1.4052-01 | 2.0285-01 | 2.7731-01 | | | | | | |

SPAN STATION 1 CHORD STATION 3

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3.8096-03 | 3.5325-02 | 6.4503-02 | 8.8804-02 | 1.0747-01 | 1.2108-01 | 1.3072-01 | 1.3708-01 | 1.4003-01 | 1.3860-01 |
| 1.3159-01 | 1.1823-01 | 9.8706-02 | 7.4258-02 | 4.6742-02 | 1.7961-02 | -1.0964-02 | -3.9855-02 | -6.9226-02 | -9.9629-02 |
| -1.3090-01 | -1.6168-01 | -1.8942-01 | -2.1093-01 | -2.2328-01 | -2.2460-01 | -2.1449-01 | -1.9390-01 | -1.6453-01 | -1.2803-01 |
| -8.5498-02 | -3.7337-02 | 1.6301-02 | 7.4881-02 | 1.3696-01 | 2.0014-01 | 2.6165-01 | 3.1930-01 | 3.7249-01 | 4.2277-01 |
| 4.7343-01 | 5.2847-01 | 5.9095-01 | 6.6150-01 | 7.3763-01 | 8.1405-01 | 8.8407-01 | 9.4154-01 | 9.8272-01 | 1.0073+00 |
| 1.0183+00 | 1.0208+00 | 1.0205+00 | 1.0213+00 | 1.0253+00 | 1.0320+00 | 1.0392+00 | 1.0449+00 | 1.0478+00 | 1.0478+00 |
| 1.0461+00 | 1.0437+00 | 1.0410+00 | 1.0367+00 | 1.0283+00 | 1.0128+00 | 9.8772-01 | 9.5242-01 | 9.0830-01 | 8.5854-01 |
| 8.0702-01 | 7.5710-01 | 7.1057-01 | 6.6729-01 | 6.2558-01 | 5.8318-01 | 5.3830-01 | 4.9044-01 | 4.4052-01 | 3.9046-01 |
| 3.4234-01 | 2.9752-01 | 2.5621-01 | 2.1743-01 | 1.7965-01 | 1.4150-01 | 1.0246-01 | 6.3202-02 | 2.5333-02 | -9.1201-03 |
| -3.8437-02 | -6.1752-02 | -7.9263-02 | -9.2051-02 | -1.0162-01 | -1.0938-01 | -1.1626-01 | -1.2256-01 | -1.2810-01 | -1.3250-01 |
| -1.3545-01 | -1.3693-01 | -1.3717-01 | -1.3660-01 | -1.3566-01 | -1.3464-01 | -1.3370-01 | -1.3288-01 | -1.3217-01 | -1.3162-01 |
| -1.3124-01 | -1.3097-01 | -1.3050-01 | -1.2919-01 | -1.2600-01 | -1.1964-01 | -1.0876-01 | -9.2273-02 | -6.9784-02 | -4.1841-02 |
| -1.0113-02 | 2.2700-02 | 5.3227-02 | 7.8044-02 | 9.4413-02 | 1.0098-01 | 9.8180-02 | 8.8237-02 | 7.4608-02 | 6.1051-02 |
| 5.0526-02 | 4.4298-02 | 4.1556-02 | 3.9734-02 | 3.5473-02 | 2.5936-02 | 1.0019-02 | -1.0966-02 | -3.3429-02 | -5.2444-02 |
| -6.3188-02 | -6.2402-02 | -4.9349-02 | -2.5970-02 | | | | | | |

SPAN STATION 1 CHORD STATION 4

Figure 3. Sample Output - Continued.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -8.8635-02 | -8.6987-02 | -8.6039-02 | -8.5464-02 | -8.4647-02 | -8.3209-02 | -8.1390-02 | -8.0108-02 | -8.0666-02 | -8.4235-02 |
| -9.1370-02 | -1.0177-01 | -1.1442-01 | -1.2800-01 | -1.4146-01 | -1.5441-01 | -1.6718-01 | -1.8059-01 | -1.9543-01 | -2.1196-01 |
| -2.2968-01 | -2.4738-01 | -2.6351-01 | -2.7668-01 | -2.8602-01 | -2.9132-01 | -2.9278-01 | -2.9068-01 | -2.8503-01 | -2.7540-01 |
| -2.6116-01 | -2.4187-01 | -2.1774-01 | -1.8993-01 | -1.6040-01 | -1.3145-01 | -1.0501-01 | -8.2041-02 | -6.2182-02 | -4.3917-02 |
| -2.5150-02 | -3.9917-03 | 2.0531-02 | 4.8109-02 | 7.7247-02 | 1.0576-01 | 1.3144-01 | 1.5269-01 | 1.6882-01 | 1.8004-01 |
| 1.8713-01 | 1.9107-01 | 1.9270-01 | 1.9266-01 | 1.9143-01 | 1.8957-01 | 1.8779-01 | 1.8691-01 | 1.8770-01 | 1.9048-01 |
| 1.9499-01 | 2.0035-01 | 2.0525-01 | 2.0841-01 | 2.0893-01 | 2.0656-01 | 2.0169-01 | 1.9505-01 | 1.8732-01 | 1.7880-01 |
| 1.6925-01 | 1.5802-01 | 1.4441-01 | 1.2805-01 | 1.0921-01 | 8.8792-02 | 6.8085-02 | 4.8386-02 | 3.0577-02 | 1.4891-02 |
| 9.3755-04 | -1.2047-02 | -2.4835-02 | -3.7887-02 | -5.1197-02 | -6.4363-02 | -7.6810-02 | -8.8073-02 | -9.7985-02 | -1.0673-01 |
| -1.1471-01 | -1.2236-01 | -1.2998-01 | -1.3757-01 | -1.4494-01 | -1.5178-01 | -1.5782-01 | -1.6291-01 | -1.6702-01 | -1.7024-01 |
| -1.7260-01 | -1.7412-01 | -1.7472-01 | -1.7433-01 | -1.7291-01 | -1.7048-01 | -1.6711-01 | -1.6284-01 | -1.5771-01 | -1.5172-01 |
| -1.4494-01 | -1.3754-01 | -1.2989-01 | -1.2244-01 | -1.1558-01 | -1.0937-01 | -1.0342-01 | -9.6896-02 | -8.8786-02 | -7.8343-02 |
| -6.5545-02 | -5.1387-02 | -3.7820-02 | -2.7286-02 | -2.1965-02 | -2.2988-02 | -2.9911-02 | -4.0696-02 | -5.2250-02 | -6.1374-02 |
| -6.5791-02 | -6.4892-02 | -5.9907-02 | -5.3433-02 | -4.8495-02 | -4.7485-02 | -5.1365-02 | -5.9429-02 | -6.9669-02 | -7.9583-02 |
| -8.7079-02 | -9.1128-02 | -9.1940-02 | -9.0640-02 | | | | | | |

SPAN STATION 1 CHORD STATION 5

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -4.0680-02 | -4.1627-02 | -4.2030-02 | -4.1855-02 | -4.1058-02 | -3.9686-02 | -3.7944-02 | -3.6199-02 | -3.4877-02 | -3.4297-02 |
| -3.4513-02 | -3.5260-02 | -3.6030-02 | -3.6274-02 | -3.5627-02 | -3.4073-02 | -3.1967-02 | -2.9884-02 | -2.8373-02 | -2.7710-02 |
| -2.7752-02 | -2.7976-02 | -2.7659-02 | -2.6156-02 | -2.3134-02 | -1.8678-02 | -1.3240-02 | -7.4440-03 | -1.8621-03 | 3.1627-03 |
| 7.5598-03 | 1.1448-02 | 1.4980-02 | 1.8194-02 | 2.0966-02 | 2.3069-02 | 2.4327-02 | 2.4764-02 | 2.4694-02 | 2.4673-02 |
| 2.5339-02 | 2.7200-02 | 3.0450-02 | 3.4900-02 | 4.0035-02 | 4.5180-02 | 4.9701-02 | 5.3157-02 | 5.5357-02 | 5.6320-02 |
| 5.6178-02 | 5.5078-02 | 5.3142-02 | 5.0481-02 | 4.7250-02 | 4.3682-02 | 4.0070-02 | 3.6690-02 | 3.3688-02 | 3.1009-02 |
| 2.8396-02 | 2.5499-02 | 2.2031-02 | 1.7931-02 | 1.3422-02 | 8.9389-03 | 4.9383-03 | 1.6626-03 | -1.0326-03 | -3.6994-03 |
| -7.1369-03 | -1.2101-02 | -1.8995-02 | -2.7675-02 | -3.7450-02 | -4.7301-02 | -5.6227-02 | -6.3579-02 | -6.9264-02 | -7.3715-02 |
| -7.7657-02 | -8.1774-02 | -8.6402-02 | -9.1405-02 | -9.6252-02 | -1.0028-01 | -1.0304-01 | -1.0447-01 | -1.0504-01 | -1.0553-01 |
| -1.0675-01 | -1.0927-01 | -1.1322-01 | -1.1829-01 | -1.2395-01 | -1.2970-01 | -1.3534-01 | -1.4104-01 | -1.4730-01 | -1.5464-01 |
| -1.6338-01 | -1.7343-01 | -1.8415-01 | -1.9451-01 | -2.0330-01 | -2.0940-01 | -2.1195-01 | -2.1055-01 | -2.0521-01 | -1.9637-01 |
| -1.8477-01 | -1.7137-01 | -1.5728-01 | -1.4358-01 | -1.3115-01 | -1.2050-01 | -1.1159-01 | -1.0385-01 | -9.6288-02 | -8.7878-02 |
| -7.7955-02 | -6.6601-02 | -5.4803-02 | -4.4302-02 | -3.7133-02 | -3.4979-02 | -3.8550-02 | -4.7214-02 | -5.9029-02 | -7.1197-02 |
| -8.0799-02 | -8.5592-02 | -8.4590-02 | -7.8258-02 | -6.8274-02 | -5.6954-02 | -4.6559-02 | -3.8715-02 | -3.4114-02 | -3.2547-02 |
| -3.3201-02 | -3.5060-02 | -3.7246-02 | -3.9201-02 | | | | | | |

SPAN STATION 2 CHORD STATION 1

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 5.3076+00 | 5.3657+00 | 5.3880+00 | 5.3760+00 | 5.3351+00 | 5.2707+00 | 5.1852+00 | 5.0775+00 | 4.9446+00 | 4.7852+00 |
| 4.6015+00 | 4.3999+00 | 4.1884+00 | 3.9727+00 | 3.7535+00 | 3.5256+00 | 3.2812+00 | 3.0145+00 | 2.7269+00 | 2.4288+00 |
| 2.1370+00 | 1.8690+00 | 1.6352+00 | 1.4342+00 | 1.2531+00 | 1.0735+00 | 8.8174-01 | 6.7725-01 | 4.7675-01 | 3.0986-01 |
| 2.0790-01 | 1.8987-01 | 2.5169-01 | 3.6431-01 | 4.8269-01 | 5.6320-01 | 5.8312-01 | 5.5400-01 | 5.2276-01 | 5.5854-01 |
| 7.2924-01 | 1.0759+00 | 1.5947+00 | 2.2338+00 | 2.9066+00 | 3.5171+00 | 3.9894+00 | 4.2882+00 | 4.4268+00 | 4.4568+00 |
| 4.4469+00 | 4.4570+00 | 4.5193+00 | 4.6313+00 | 4.7626+00 | 4.8719+00 | 4.9259+00 | 4.9127+00 | 4.8451+00 | 4.7522+00 |
| 4.6664+00 | 4.6094+00 | 4.5837+00 | 4.5746+00 | 4.5574+00 | 4.5097+00 | 4.4206+00 | 4.2943+00 | 4.1468+00 | 3.9973+00 |
| 3.8603+00 | 3.7395+00 | 3.6265+00 | 3.5158+00 | 3.3920+00 | 3.2557+00 | 3.1147+00 | 2.9834+00 | 2.8762+00 | 2.8017+00 |
| 2.7595+00 | 2.7409+00 | 2.7335+00 | 2.7265+00 | 2.7150+00 | 2.7002+00 | 2.6877+00 | 2.6822+00 | 2.6844+00 | 2.6893+00 |
| 2.6881+00 | 2.6723+00 | 2.6372+00 | 2.5843+00 | 2.5199+00 | 2.4520+00 | 2.3863+00 | 2.3235+00 | 2.2600+00 | 2.1908+00 |
| 2.1137+00 | 2.0325+00 | 1.9573+00 | 1.9017+00 | 1.8771+00 | 1.8880+00 | 1.9294+00 | 1.9879+00 | 2.0469+00 | 2.0924+00 |
| 2.1185+00 | 2.1294+00 | 2.1368+00 | 2.1553+00 | 2.1964+00 | 2.2643+00 | 2.3556+00 | 2.4614+00 | 2.5726+00 | 2.6830+00 |
| 2.7918+00 | 2.9023+00 | 3.0186+00 | 3.1427+00 | 3.2722+00 | 3.4014+00 | 3.5239+00 | 3.6363+00 | 3.7397+00 | 3.8401+00 |
| 3.9446+00 | 4.0586+00 | 4.1814+00 | 4.3070+00 | 4.4256+00 | 4.5283+00 | 4.6118+00 | 4.6798+00 | 4.7425+00 | 4.8120+00 |
| 4.8971+00 | 4.9992+00 | 5.1109+00 | 5.2188+00 | | | | | | |

SPAN STATION 2 CHORD STATION 2

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3.2571+00 | 3.3087+00 | 3.3519+00 | 3.3902+00 | 3.4258+00 | 3.4577+00 | 3.4822+00 | 3.4948+00 | 3.4925+00 | 3.4764+00 |
| 3.4513+00 | 3.4240+00 | 3.4004+00 | 3.3819+00 | 3.3641+00 | 3.3386+00 | 3.2956+00 | 3.2280+00 | 3.1350+00 | 3.0216+00 |
| 2.6966+00 | 2.7682+00 | 2.6405+00 | 2.5117+00 | 2.3759+00 | 2.2284+00 | 2.0703+00 | 1.9118+00 | 1.7712+00 | 1.6696+00 |

Figure 3. Sample Output - Continued.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1.6226+00 | 1.6335+00 | 1.6896+00 | 1.7660+00 | 1.8334+00 | 1.8708+00 | 1.8743+00 | 1.8620+00 | 1.8691+00 | 1.9367+00 |
| 2.0966+00 | 2.3588+00 | 2.7050+00 | 3.0922+00 | 3.4641+00 | 3.7680+00 | 3.9685+00 | 4.0572+00 | 4.0514+00 | 3.9858+00 |
| 3.8995+00 | 3.8226+00 | 3.7693+00 | 3.7364+00 | 3.7094+00 | 3.6715+00 | 3.6115+00 | 3.5287+00 | 3.4317+00 | 3.3337+00 |
| 3.2462+00 | 3.1739+00 | 3.1135+00 | 3.0559+00 | 2.9907+00 | 2.9108+00 | 2.8152+00 | 2.7082+00 | 2.5971+00 | 2.4882+00 |
| 2.3646+00 | 2.2855+00 | 2.1878+00 | 2.0891+00 | 1.9898+00 | 1.8938+00 | 1.8070+00 | 1.7347+00 | 1.6795+00 | 1.6395+00 |
| 1.6097+00 | 1.5838+00 | 1.5574+00 | 1.5297+00 | 1.5035+00 | 1.4831+00 | 1.4717+00 | 1.4690+00 | 1.4704+00 | 1.4686+00 |
| 1.4560+00 | 1.4281+00 | 1.3850+00 | 1.3313+00 | 1.2742+00 | 1.2204+00 | 1.1738+00 | 1.1341+00 | 1.0981+00 | 1.0620+00 |
| 1.0242+00 | 9.8639-01 | 9.5374-01 | 9.3277-01 | 9.2864-01 | 9.4286-01 | 9.7255-01 | 1.0114+00 | 1.0521+00 | 1.0891+00 |
| 1.1201+00 | 1.1465+00 | 1.1722+00 | 1.2017+00 | 1.2377+00 | 1.2809+00 | 1.3301+00 | 1.3832+00 | 1.4391+00 | 1.4974+00 |
| [illegible]91+00 | 1.6249+00 | 1.6944+00 | 1.7657+00 | 1.8361+00 | 1.9030+00 | 1.9660+00 | 2.0268+00 | 2.0891+00 | 2.1568+00 |
| 2.[illegible]24+00 | 2.3150+00 | 2.4008+00 | 2.4844+00 | 2.5608+00 | 2.6283+00 | 2.6886+00 | 2.7468+00 | 2.8086+00 | 2.8783+00 |
| 2.9563+00 | 3.0390+00 | 3.1203+00 | 3.1943+00 | | | | | | |

SPAN STATION 2 CHORD STATION 3

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1.7878+00 | 1.8038+00 | 1.8105+00 | 1.8061+00 | 1.7906+00 | 1.7658+00 | 1.7344+00 | 1.6997+00 | 1.6639+00 | 1.6278+00 |
| 1.5902+00 | 1.5488+00 | 1.5004+00 | 1.4428+00 | 1.3753+00 | 1.2996+00 | 1.2193+00 | 1.1391+00 | 1.0632+00 | 9.9395-01 |
| 9.3078-01 | 8.7055-01 | 8.0855-01 | 7.4046-01 | 6.6445-01 | 5.8268-01 | 5.0154-01 | 4.3039-01 | 3.7903-01 | 3.5471-01 |
| 3.5962-01 | 3.8990-01 | 4.3663-01 | 4.8858-01 | 5.3601-01 | 5.7412-01 | 6.0501-01 | 6.3733-01 | 6.8360-01 | 7.5596-01 |
| 8.6182-01 | 1.0006+00 | 1.1640+00 | 1.3362+00 | 1.4993+00 | 1.6377+00 | 1.7416+00 | 1.8089+00 | 1.8450+00 | 1.8595+00 |
| 1.8629+00 | 1.8633+00 | 1.8643+00 | 1.8654+00 | 1.8630+00 | 1.8536+00 | 1.8351+00 | 1.8085+00 | 1.7770+00 | 1.7449+00 |
| 1.7155+00 | 1.6902+00 | 1.6674+00 | 1.6439+00 | 1.6162+00 | 1.5817+00 | 1.5398+00 | 1.4920+00 | 1.4413+00 | 1.3905+00 |
| 1.3417+00 | 1.2955+00 | 1.2515+00 | 1.2089+00 | 1.1677+00 | 1.1288+00 | 1.0941+00 | 1.0659+00 | 1.0460+00 | 1.0345+00 |
| 1.0300+00 | 1.0301+00 | 1.0314+00 | 1.0317+00 | 1.0292+00 | 1.0239+00 | 1.0161+00 | 1.0063+00 | 9.9432-01 | 9.7924-01 |
| 9.5948-01 | 9.3357-01 | 9.0081-01 | 8.6172-01 | 8.1799-01 | 7.7200-01 | 7.2617-01 | 6.8236-01 | 6.4166-01 | 6.0466-01 |
| 5.7198-01 | 5.4483-01 | 5.2519-01 | 5.1553-01 | 5.1801-01 | 5.3359-01 | 5.6124-01 | 5.9780-01 | 6.3851-01 | 6.7811-01 |
| 7.1226-01 | 7.3863-01 | 7.5744-01 | 7.7124-01 | 7.8399-01 | 7.9978-01 | 8.2160-01 | 8.5061-01 | 8.8598-01 | 9.2536-01 |
| 9.6574-01 | 1.0044+00 | 1.0396+00 | 1.0709+00 | 1.0995+00 | 1.1273+00 | 1.1567+00 | 1.1899+00 | 1.2285+00 | 1.2730+00 |
| 1.3227+00 | 1.3760+00 | 1.4302+00 | 1.4824+00 | 1.5299+00 | 1.5707+00 | 1.6041+00 | 1.6309+00 | 1.6530+00 | 1.6731+00 |
| 1.6937+00 | 1.7163+00 | 1.7408+00 | 1.7656+00 | | | | | | |

SPAN STATION 2 CHORD STATION 4

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 5.3725-01 | 5.3835-01 | 5.3714-01 | 5.3387-01 | 5.2888-01 | 5.2239-01 | 5.1432-01 | 5.0431-01 | 4.9194-01 | 4.7691-01 |
| 4.5919-01 | 4.3899-01 | 4.1662-01 | 3.9232-01 | 3.6612-01 | 3.3791-01 | 3.0766-01 | 2.7569-01 | 2.4284-01 | 2.1040-01 |
| 1.7978-01 | 1.5208-01 | 1.2768-01 | 1.0606-01 | 8.6101-02 | 6.6665-02 | 4.7297-02 | 2.8774-02 | 1.3173-02 | 3.3906-03 |
| 2.2134-03 | 1.1281-02 | 3.0343-02 | 5.7149-02 | 8.8058-02 | 1.1921-01 | 1.4781-01 | 1.7311-01 | 1.9660-01 | 2.2144-01 |
| 2.5117-01 | 2.8831-01 | 3.3330-01 | 3.8410-01 | 4.3675-01 | 4.8646-01 | 5.2905-01 | 5.6203-01 | 5.8506-01 | 5.9970-01 |
| 6.0854-01 | 6.1417-01 | 6.1833-01 | 6.2158-01 | 6.2347-01 | 6.2312-01 | 6.1991-01 | 6.1387-01 | 6.0578-01 | 5.9682-01 |
| 5.8810-01 | 5.8014-01 | 5.7267-01 | 5.6474-01 | 5.5511-01 | 5.4273-01 | 5.2707-01 | 5.0833-01 | 4.8724-01 | 4.6483-01 |
| 4.4212-01 | 4.1989-01 | 3.9865-01 | 3.7873-01 | 3.6045-01 | 3.4415-01 | 3.3024-01 | 3.1903-01 | 3.1062-01 | 3.0482-01 |
| 3.0112-01 | 2.9881-01 | 2.9716-01 | 2.9555-01 | 2.9347-01 | 2.9055-01 | 2.8644-01 | 2.8073-01 | 2.7299-01 | 2.6287-01 |
| 2.5025-01 | 2.3536-01 | 2.1884-01 | 2.0157-01 | 1.8454-01 | 1.6857-01 | 1.5419-01 | 1.4161-01 | 1.3087-01 | 1.2202-01 |
| 1.1525-01 | 1.1097-01 | 1.0967-01 | 1.1165-01 | 1.1688-01 | 1.2475-01 | 1.3423-01 | 1.4403-01 | 1.5298-01 | 1.6030-01 |
| 1.6581-01 | 1.6990-01 | 1.7334-01 | 1.7700-01 | 1.8160-01 | 1.8760-01 | 1.9512-01 | 2.0407-01 | 2.1426-01 | 2.2545-01 |
| 2.3740-01 | 2.4979-01 | 2.6231-01 | 2.7464-01 | 2.8662-01 | 2.9838-01 | 3.1043-01 | 3.2358-01 | 3.3875-01 | 3.5656-01 |
| 3.7708-01 | 3.9958-01 | 4.2270-01 | 4.4468-01 | 4.6391-01 | 4.7939-01 | 4.9097-01 | 4.9932-01 | 5.0565-01 | 5.1124-01 |
| 5.1694-01 | 5.2296-01 | 5.2889-01 | 5.3393-01 | | | | | | |

SPAN STATION 2 CHORD STATION 5

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -2.9588-01 | -3.1349-01 | -3.3155-01 | -3.5043-01 | -3.7005-01 | -3.8989-01 | -4.0920-01 | -4.2739-01 | -4.4435-01 | -4.6056-01 |
| -4.7692-01 | -4.9430-01 | -5.1309-01 | -5.3277-01 | -5.5201-01 | -5.6905-01 | -5.8230-01 | -5.9101-01 | -5.9557-01 | -5.9746-01 |
| -5.9862-01 | -6.0075-01 | -6.0460-01 | -6.0968-01 | -6.1453-01 | -6.1736-01 | -6.1685-01 | -6.1279-01 | -6.0619-01 | -5.9888-01 |
| -5.9273-01 | -5.8884-01 | -5.8704-01 | -5.8598-01 | -5.8373-01 | -5.7867-01 | -5.7024-01 | -5.5929-01 | -5.4775-01 | -5.3781-01 |
| -5.3089-01 | -5.2695-01 | -5.2430-01 | -5.2019-01 | -5.1179-01 | -4.9737-01 | -4.7698-01 | -4.5257-01 | -4.2730-01 | -4.0444-01 |
| -3.8624-01 | -3.7320-01 | -3.6399-01 | -3.5612-01 | -3.4693-01 | -3.3461-01 | -3.1879-01 | -3.0053-01 | -2.8176-01 | -2.6442-01 |
| -2.4977-01 | -2.3792-01 | -2.2804-01 | -2.1884-01 | -2.0919-01 | -1.9863-01 | -1.8747-01 | -1.7657-01 | -1.6684-01 | -1.5876-01 |
| -1.5219-01 | -1.4640-01 | -1.4043-01 | -1.3354-01 | -1.2547-01 | -1.1656-01 | -1.0753-01 | -9.9086-02 | -9.1641-02 | -8.5125-02 |

Figure 3. Sample Output - Continued.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -7.9088-02 | -7.2979-02 | -6.6475-02 | -5.9692-02 | -5.3195-02 | -4.7787-02 | -4.4[illegible]93-02 | -4.2775-02 | -4.3412-02 | -4.5579-02 |
| -4.8586-02 | -5.1847-02 | -5.5074-02 | -5.8288-02 | -6.1684-02 | -6.5410-02 | -6.9386-02 | -7.3251-02 | -7.6443-02 | -7.8407-02 |
| -7.8794-02 | -7.7577-02 | -7.5038-02 | -7.1642-02 | -6.7864-02 | -6.4060-02 | -6.0440-02 | -5.7126-02 | -5.4262-02 | -5.2093-02 |
| -5.0952-02 | -5.1160-02 | -5.2878-02 | -5.5997-02 | -6.0124-02 | -6.4689-02 | -6.9132-02 | -7.3098-02 | -7.6536-02 | -7.9682-02 |
| -8.2908-02 | -8.6537-02 | -9.0686-02 | -9.5224-02 | -9.9852-02 | -1.0425-01 | -1.0826-01 | -1.1190-01 | -1.1540-01 | -1.1905-01 |
| -1.2307-01 | -1.2756-01 | -1.3255-01 | -1.3811-01 | -1.4447-01 | -1.5205-01 | -1.6145-01 | -1.7317-01 | -1.8742-01 | -2.0396-01 |
| -2.2215-01 | -2.4107-01 | -2.5989-01 | -2.7816-01 | | | | | | |

SPAN STATION 3 CHORD STATION 1

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8.2907+00 | 8.2104+00 | 8.0435+00 | 7.8020+00 | 7.5095+00 | 7.1950+00 | 6.8847+00 | 6.5948+00 | 6.3280+00 | 6.0789+00 |
| 5.8197+00 | 5.5481+00 | 5.2536+00 | 4.9409+00 | 4.6231+00 | 4.3163+00 | 4.0322+00 | 3.7725+00 | 3.5289+00 | 3.2863+00 |
| 3.0303+00 | 2.7540+00 | 2.4616+00 | 2.1675+00 | 1.8896+00 | 1.6416+00 | 1.4270+00 | 1.2369+00 | 1.0552+00 | 8.6650-01 |
| 6.6600-01 | 4.6529-01 | 2.9154-01 | 1.7981-01 | 1.6083-01 | 2.4884-01 | 4.3447-01 | 6.8559-01 | 9.5637-01 | 1.2014+00 |
| 1.3898+00 | 1.5141+00 | 1.5911+00 | 1.6540+00 | 1.7397+00 | 1.8758+00 | 2.0717+00 | 2.3173+00 | 2.5886+00 | 2.8573+00 |
| 3.1011+00 | 3.3096+00 | 3.4858+00 | 3.6394+00 | 3.7819+00 | 3.9192+00 | 4.0487+00 | 4.1613+00 | 4.2461+00 | 4.2958+00 |
| 4.3106+00 | 4.2986+00 | 4.2725+00 | 4.2446+00 | 4.2220+00 | 4.2046+00 | 4.1854+00 | 4.1546+00 | 4.1039+00 | 4.0298+00 |
| 3.9345+00 | 3.8253+00 | 3.7105+00 | 3.5973+00 | 3.4890+00 | 3.3859+00 | 3.2869+00 | 3.1918+00 | 3.1028+00 | 3.0283+00 |
| 2.9657+00 | 2.9300+00 | 2.9210+00 | 2.9377+00 | 2.9753+00 | 3.0272+00 | 3.0864+00 | 3.1468+00 | 3.2041+00 | 3.2550+00 |
| 3.2970+00 | 3.3273+00 | 3.3433+00 | 3.3436+00 | 3.3282+00 | 3.2990+00 | 3.2600+00 | 3.2153+00 | 3.1687+00 | 3.1228+00 |
| 3.0791+00 | 3.0393+00 | 3.0069+00 | 2.9875+00 | 2.9886+00 | 3.0178+00 | 3.0798+00 | 3.1740+00 | 3.2936+00 | 3.4264+00 |
| 3.5579+00 | 3.6761+00 | 3.7748+00 | 3.8557+00 | 3.9284+00 | 4.0065+00 | 4.1039+00 | 4.2301+00 | 4.3874+00 | 4.5707+00 |
| 4.7691+00 | 4.9695+00 | 5.1601+00 | 5.3335+00 | 5.4874+00 | 5.6246+00 | 5.7515+00 | 5.8759+00 | 6.0051+00 | 6.1443+00 |
| 6.2956+00 | 6.4583+00 | 6.6288+00 | 6.8021+00 | 6.9734+00 | 7.1393+00 | 7.2998+00 | 7.4572+00 | 7.6153+00 | 7.7761+00 |
| 7.9370+00 | 8.0880+00 | 8.2117+00 | 8.2864+00 | | | | | | |

SPAN STATION 3 CHORD STATION 2

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4.0340+00 | 4.1810+00 | 4.3486+00 | 4.5202+00 | 4.6715+00 | 4.7765+00 | 4.8128+00 | 4.7682+00 | 4.6438+00 | 4.4541+00 |
| 4.2229+00 | 3.9766+00 | 3.7370+00 | 3.5156+00 | 3.3113+00 | 3.1121+00 | 2.9014+00 | 2.6644+00 | 2.3952+00 | 2.1001+00 |
| 1.7970+00 | 1.5109+00 | 1.2662+00 | 1.0797+00 | 9.5498-01 | 8.8148-01 | 8.3786-01 | 7.9879-01 | 7.4309-01 | 6.6058-01 |
| 5.5521-01 | 4.4406-01 | 3.5159-01 | 3.0195-01 | 3.1133-01 | 3.8307-01 | 5.0698-01 | 6.6319-01 | 8.2906-01 | 9.8680-01 |
| 1.1293+00 | 1.2616+00 | 1.3996+00 | 1.5617+00 | 1.7626+00 | 2.0065+00 | 2.2835+00 | 2.5711+00 | 2.8397+00 | 3.0603+00 |
| 3.2119+00 | 3.2868+00 | 3.2912+00 | 3.2427+00 | 3.1636+00 | 3.0752+00 | 2.9918+00 | 2.9190+00 | 2.8544+00 | 2.7911+00 |
| 2.7220+00 | 2.6433+00 | 2.5561+00 | 2.4656+00 | 2.3782+00 | 2.2991+00 | 2.2299+00 | 2.1678+00 | 2.1074+00 | 2.0425+00 |
| 1.9686+00 | 1.8850+00 | 1.7943+00 | 1.7018+00 | 1.6135+00 | 1.5342+00 | 1.4665+00 | 1.4109+00 | 1.3665+00 | 1.3321+00 |
| 1.3073+00 | 1.2927+00 | 1.2888+00 | 1.2959+00 | 1.3124+00 | 1.3349+00 | 1.3587+00 | 1.3786+00 | 1.3902+00 | 1.3912+00 |
| [illegible].3819+00 | 1.3642+00 | 1.3410+00 | 1.3151+00 | 1.2880+00 | 1.2598+00 | 1.2295+00 | 1.1958+00 | 1.1583+00 | 1.1180+00 |
| 1.0782+00 | 1.0434+00 | 1.0193+00 | 1.0113+00 | 1.0234+00 | 1.0574+00 | 1.1119+00 | 1.1829+00 | 1.2637+00 | 1.3467+00 |
| 1.4247+00 | 1.4923+00 | 1.5475+00 | 1.5921+00 | 1.631[illegible] | 1.6717+00 | 1.7207+00 | 1.7832+00 | 1.8605+00 | 1.9498+00 |
| 2.0455+00 | 2.1406+00 | 2.2291+00 | 2.3077+00 | 2.3770+00 | 2.4403+00 | 2.5032+00 | 2.5707+00 | 2.6465+00 | 2.7313+00 |
| 2.8236+00 | 2.9207+00 | 3.0193+00 | 3.1171+00 | 3.2127+00 | 3.3053+00 | 3.3937+00 | 3.4767+00 | 3.5528+00 | 3.6216+00 |
| 3.6853+00 | 3.7494+00 | 3.8228+00 | 3.9151+00 | | | | | | |

SPAN STATION 3 CHORD STATION 3

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2.9525+00 | 2.9614+00 | 3.0123+00 | 3.0399+00 | 3.0598+00 | 3.0709+00 | 3.0762+00 | 3.0807+00 | 3.0873+00 | 3.0934+00 |
| 3.0909+00 | 3.0700+00 | 3.0263+00 | 2.9680+00 | 2.9191+00 | 2.9153+00 | 2.9928+00 | 3.1731+00 | 3.4496+00 | 3.7826+00 |
| 4.1065+00 | 4.3479+00 | 4.4497+00 | 4.3911+00 | 4.1966+00 | 3.9282+00 | 3.6635+00 | 3.4669+00 | 3.3659+00 | 3.3414+00 |
| 3.3383+00 | 3.2915+00 | 3.1579+00 | 2.9413+00 | 2.6988+00 | 2.5239+00 | 2.5125+00 | 2.7227+00 | 3.1456+00 | 3.6983+00 |
| 4.2441+00 | 4.6330+00 | 4.7507+00 | 4.5556+00 | 4.0935+00 | 3.4824+00 | 2.8749+00 | 2.4097+00 | 2.1714+00 | 2.1699+00 |
| 2.3464+00 | 2.6007+00 | 2.8294+00 | 2.9592+00 | 2.9654+00 | 2.8702+00 | 2.7248+00 | 2.5838+00 | 2.4836+00 | 2.4319+00 |
| 2.4107+00 | 2.3902+00 | 2.3444+00 | 2.2631+00 | 2.1549+00 | 2.0403+00 | 1.9409+00 | 1.8689+00 | 1.8219+00 | 1.7858+00 |
| 1.7423+00 | 1.6779+00 | 1.5906+00 | 1.4898+00 | 1.3918+00 | 1.3118+00 | 1.2579+00 | 1.2284+00 | 1.2137+00 | 1.2026+00 |
| 1.1873+00 | 1.1674+00 | 1.1487+00 | 1.1394+00 | 1.1449+00 | 1.1644+00 | 1.1904+00 | 1.2120+00 | 1.2197+00 | 1.2095+00 |
| 1.18[illegible]5+00 | 1.1527+00 | 1.1231+00 | 1.1007+00 | 1.0848+00 | 1.0693+00 | 1.0462+00 | 1.0098+00 | 9.6066-01 | 9.0860-01 |
| 8.5558-01 | 8.2156-01 | 8.1046-01 | 8.2308-01 | 8.5470-01 | 8.9789-01 | 9.4588-01 | 9.9501-01 | 1.0450+00 | 1.0972+00 |
| 1.1525+00 | 1.2090+00 | 1.2625+00 | 1.3081+00 | 1.3431+00 | 1.3690+00 | 1.3916+00 | 1.4195+00 | 1.4598+00 | 1.5155+00 |
| 1.5838+00 | 1.6568+00 | 1.7253+00 | 1.7825+00 | 1.8268+00 | 1.8627+00 | 1.8984+00 | 1.9424+00 | 2.0001+00 | 2.0717+00 |

Figure 3. Sample Output - Continued.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 2.1529+00 | 2.2374+00 | 2.3201+00 | 2.3984+00 | 2.4733+00 | 2.5468+00 | 2.6201+00 | 2.6918+00 | 2.7578+00 | 2.8134+00 |
| 2.8558+00 | 2.8858+00 | 2.9079+00 | 2.9285+00 | | | | | | |

SPAN STATION 3 CHORD STATION 4

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1.7042-01 | 1.5219-01 | 1.3310-01 | 1.1253-01 | 9.0002-02 | 6.5381-02 | 3.8924-02 | 1.1192-02 | -1.7189-02 | -4.5807-02 |
| -7.4661-02 | -1.0421-01 | -1.3523-01 | -1.6861-01 | -2.0501-01 | -2.4470-01 | -2.8754-01 | -3.3302-01 | -3.8050-01 | -4.2934-01 |
| -4.7901-01 | -5.2900-01 | -5.7860-01 | -6.2675-01 | -6.7183-01 | -7.1177-01 | -7.4425-01 | -7.6716-01 | -7.7911-01 | -7.7980-01 |
| -7.7023-01 | -7.5263-01 | -7.3007-01 | -7.0589-01 | -6.8302-01 | -6.6338-01 | -6.4752-01 | -6.3451-01 | -6.2221-01 | -6.0781-01 |
| -5.8846-01 | -5.6199-01 | -5.2748-01 | -4.8543-01 | -4.3778-01 | -3.8739-01 | -3.3751-01 | -2.9105-01 | -2.5007-01 | -2.1548-01 |
| -1.8709-01 | -1.6392-01 | -1.4466-01 | -1.2814-01 | -1.1360-01 | -1.0081-01 | -8.9869-02 | -8.0964-02 | -7.4117-02 | -6.9049-02 |
| -6.5226-02 | -6.2059-02 | -5.9148-02 | -5.6471-02 | -5.4413-02 | -5.3631-02 | -5.4795-02 | -5.8321-02 | -6.4199-02 | -7.1981-02 |
| -8.0921-02 | -9.0204-02 | -9.9154-02 | -1.0734-01 | -1.1452-01 | -1.2055-01 | -1.2516-01 | -1.2791-01 | -1.2822-01 | -1.2555-01 |
| -1.1961-01 | -1.1061-01 | -9.9277-02 | -8.6796-02 | -7.4533-02 | -6.3758-02 | -5.5388-02 | -4.9864-02 | -4.7178-02 | -4.7016-02 |
| -4.8949-02 | -5.2574-02 | -5.7589-02 | -6.3765-02 | -7.0886-02 | -7.8685-02 | -8.6825-02 | -9.4921-02 | -1.0256-01 | -1.0931-01 |
| -1.1465-01 | -1.1793-01 | -1.1827-01 | -1.1470-01 | -1.0636-01 | -9.2797-02 | -7.4347-02 | -5.2344-02 | -2.9063-02 | -7.3466-03 |
| 1.0031-02 | 2.1099-02 | 2.5281-02 | 2.3638-02 | 1.8635-02 | 1.3497-02 | 1.1314-02 | 1.4191-02 | 2.2706-02 | 3.5843-02 |
| 5.1414-02 | 6.6810-02 | 7.9843-02 | 8.9387-02 | 9.5649-02 | 1.0001-01 | 1.0454-01 | 1.1131-01 | 1.2184-01 | 1.3671-01 |
| 1.5548-01 | 1.7685-01 | 1.9900-01 | 2.1995-01 | 2.3789-01 | 2.5137-01 | 2.5944-01 | 2.6171-01 | 2.5833-01 | 2.4995-01 |
| 2.3760-01 | 2.2247-01 | 2.0573-01 | 1.8824-01 | | | | | | |

SPAN STATION 3 CHORD STATION 5

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -5.4397-01 | -5.6649-01 | -5.8849-01 | -6.0934-01 | -6.2881-01 | -6.4716-01 | -6.6496-01 | -6.8286-01 | -7.0132-01 | -7.2044-01 |
| -7.3988-01 | -7.5902-01 | -7.7714-01 | -7.9366-01 | -8.0824-01 | -8.2078-01 | -8.3131-01 | -8.3986-01 | -8.4629-01 | -8.5036-01 |
| -8.5182-01 | -8.5057-01 | -8.4681-01 | -8.4107-01 | -8.3408-01 | -8.2654-01 | -8.1890-01 | -8.1124-01 | -8.0331-01 | -7.9475-01 |
| -7.8538-01 | -7.7547-01 | -7.6575-01 | -7.5729-01 | -7.5103-01 | -7.4735-01 | -7.4572-01 | -7.4465-01 | -7.4199-01 | -7.3548-01 |
| -7.2349-01 | -7.0554-01 | -6.8255-01 | -6.5664-01 | -6.3057-01 | -6.0692-01 | -5.8743-01 | -5.7252-01 | -5.6131-01 | -5.5200-01 |
| -5.4249-01 | -5.3112-01 | -5.1706-01 | -5.0052-01 | -4.8257-01 | -4.6464-01 | -4.4804-01 | -4.3358-01 | -4.2135-01 | -4.1085-01 |
| -4.0122-01 | -3.9165-01 | -3.8162-01 | -3.7109-01 | -3.6045-01 | -3.5032-01 | -3.4133-01 | -3.3387-01 | -3.2800-01 | -3.2346-01 |
| -3.1972-01 | -3.1621-01 | -3.1246-01 | -3.0820-01 | -3.0342-01 | -2.9830-01 | -2.9315-01 | -2.8830-01 | -2.8397-01 | -2.8025-01 |
| -2.7710-01 | -2.7441-01 | -2.7204-01 | -2.6995-01 | -2.6819-01 | -2.6691-01 | -2.6629-01 | -2.6651-01 | -2.6761-01 | -2.6949-01 |
| -2.7194-01 | -2.7466-01 | -2.7748-01 | -2.8022-01 | -2.8293-01 | -2.8576-01 | -2.8886-01 | -2.9230-01 | -2.9591-01 | -2.9930-01 |
| -3.0192-01 | -3.0318-01 | -3.0267-01 | -3.0027-01 | -2.9628-01 | -2.9136-01 | -2.8642-01 | -2.8244-01 | -2.8024-01 | -2.8038-01 |
| -2.8302-01 | -2.8796-01 | -2.9472-01 | -3.0260-01 | -3.1090-01 | -3.1892-01 | -3.2615-01 | -3.3230-01 | -3.3730-01 | -3.4137-01 |
| -3.4491-01 | -3.4841-01 | -3.5233-01 | -3.5694-01 | -3.6225-01 | -3.6798-01 | -3.7364-01 | -3.7872-01 | -3.8284-01 | -3.8592-01 |
| -3.8820-01 | -3.9024-01 | -3.9270-01 | -3.9622-01 | -4.0121-01 | -4.0785-01 | -4.1610-01 | -4.2588-01 | -4.3716-01 | -4.5008-01 |
| -4.6488-01 | -4.8180-01 | -5.0087-01 | -5.2181-01 | | | | | | |

SPAN STATION 4 CHORD STATION 1

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8.8080+00 | 8.5549+00 | 8.3034+00 | 8.0504+00 | 7.7850+00 | 7.4964+00 | 7.1800+00 | 6.8407+00 | 6.4913+00 | 6.1480+00 |
| 5.8239+00 | 5.5252+00 | 5.2506+00 | 4.9939+00 | 4.7496+00 | 4.5154+00 | 4.2940+00 | 4.0894+00 | 3.9027+00 | 3.7278+00 |
| 3.5502+00 | 3.3514+00 | 3.1150+00 | 2.8354+00 | 2.5221+00 | 2.1996+00 | 1.9011+00 | 1.6581+00 | 1.4907+00 | 1.4006+00 |
| 1.3717+00 | 1.3763+00 | 1.3855+00 | 1.3795+00 | 1.3537+00 | 1.3188+00 | 1.2948+00 | 1.3016+00 | 1.3610+00 | 1.4424+00 |
| 1.5633+00 | 1.6958+00 | 1.8241+00 | 1.9409+00 | 2.0497+00 | 2.1629+00 | 2.2959+00 | 2.4604+00 | 2.6594+00 | 2.8858+00 |
| 3.1246+00 | 3.3576+00 | 3.5681+00 | 3.7449+00 | 3.8831+00 | 3.9834+00 | 4.0499+00 | 4.0876+00 | 4.1020+00 | 4.0983+00 |
| 4.0820+00 | 4.0586+00 | 4.0332+00 | 4.0089+00 | 3.9856+00 | 3.9596+00 | 3.9248+00 | 3.8747+00 | 3.8051+00 | 3.7158+00 |
| 3.6111+00 | 3.4981+00 | 3.3848+00 | 3.2772+00 | 3.1786+00 | 3.0891+00 | 3.0077+00 | 2.9342+00 | 2.8703+00 | 2.8197+00 |
| 2.7866+00 | 2.7736+00 | 2.7813+00 | 2.8059+00 | 2.8423+00 | 2.8850+00 | 2.9303+00 | 2.9766+00 | 3.0241+00 | 3.0725+00 |
| 3.1197+00 | 3.1612+00 | 3.1907+00 | 3.2030+00 | 3.1965+00 | 3.1746+00 | 3.1455+00 | 3.1194+00 | 3.1052+00 | 3.1082+00 |
| 3.1289+00 | 3.1652+00 | 3.2157+00 | 3.2831+00 | 3.3753+00 | 3.5030+00 | 3.6753+00 | 3.8935+00 | 4.1479+00 | 4.4173+00 |
| 4.6749+00 | 4.8963+00 | 5.0681+00 | 5.1938+00 | 5.2928+00 | 5.3944+00 | 5.5272+00 | 5.7091+00 | 5.9407+00 | 6.2062+00 |
| 6.4798+00 | 6.7361+00 | 6.9600+00 | 7.1517+00 | 7.3250+00 | 7.5005+00 | 7.6954+00 | 7.9155+00 | 8.1528+00 | 8.3887+00 |
| 8.6021+00 | 8.7785+00 | 8.9160+00 | 9.0252+00 | 9.1235+00 | 9.2262+00 | 9.3380+00 | 9.4492+00 | 9.5345+00 | 9.5796+00 |
| 9.5522+00 | 9.4484+00 | 9.2760+00 | 9.0547+00 | | | | | | |

SPAN STATION 4 CHORD STATION 2

Figure 3. Sample Output - Continued.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4.1000+00 | 4.1721+00 | 4.2522+00 | 4.3273+00 | 4.3819+00 | 4.4020+00 | 4.3785+00 | 4.3098+00 | 4.2016+00 | 4.0649+00 |
| 3.9127+00 | 3.7571+00 | 3.6070+00 | 3.4679+00 | 3.3422+00 | 3.2310+00 | 3.1339+00 | 3.0498+00 | 2.9754+00 | 2.9050+00 |
| 2.8308+00 | 2.7440+00 | 2.6379+00 | 2.5101+00 | 2.3646+00 | 2.2110+00 | 2.0624+00 | 1.9312+00 | 1.8262+00 | 1.7492+00 |
| 1.6962+00 | 1.6589+00 | 1.6291+00 | 1.6018+00 | 1.5769+00 | 1.5586+00 | 1.5528+00 | 1.5633+00 | 1.5891+00 | 1.6242+00 |
| 1.6593+00 | 1.6853+00 | 1.6976+00 | 1.6986+00 | 1.6976+00 | 1.7084+00 | 1.7445+00 | 1.8151+00 | 1.9214+00 | 2.0565+00 |
| 2.2067+00 | 2.3552+00 | 2.4863+00 | 2.5877+00 | 2.6528+00 | 2.6799+00 | 2.6714+00 | 2.6321+00 | 2.5685+00 | 2.4880+00 |
| 2.3986+00 | 2.3085+00 | 2.2251+00 | 2.1538+00 | 2.0967+00 | 2.0517+00 | 2.0137+00 | 1.9757+00 | 1.9311+00 | 1.8761+00 |
| 1.8107+00 | 1.7384+00 | 1.6651+00 | 1.5966+00 | 1.5371+00 | 1.4880+00 | 1.4485+00 | 1.4169+00 | 1.3916+00 | 1.3727+00 |
| 1.3617+00 | 1.3607+00 | 1.3713+00 | 1.3933+00 | 1.4243+00 | 1.4604+00 | 1.4971+00 | 1.5310+00 | 1.5598+00 | 1.5832+00 |
| 1.6014+00 | 1.6151+00 | 1.6242+00 | 1.6282+00 | 1.6269+00 | 1.6206+00 | 1.6115+00 | 1.6031+00 | 1.5994+00 | 1.6042+00 |
| 1.6199+00 | 1.6475+00 | 1.6867+00 | 1.7374+00 | 1.7999+00 | 1.8748+00 | 1.9629+00 | 2.0629+00 | 2.1707+00 | 2.2792+00 |
| 2.3792+00 | 2.4622+00 | 2.5234+00 | 2.5639+00 | 2.5912+00 | 2.6173+00 | 2.6549+00 | 2.7132+00 | 2.7946+00 | 2.8941+00 |
| 3.0006+00 | 3.1018+00 | 3.1880+00 | 3.2560+00 | 3.3098+00 | 3.3587+00 | 3.4132+00 | 3.4809+00 | 3.5634+00 | 3.6555+00 |
| 3.7476+00 | 3.8290+00 | 3.8917+00 | 3.9326+00 | 3.9540+00 | 3.9616+00 | 3.9620+00 | 3.9606+00 | 3.9604+00 | 3.9628+00 |
| 3.9690+00 | 3.9817+00 | 4.0050+00 | 4.0436+00 | | | | | | |

SPAN STATION 4 CHORD STATION 3

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1.9663+00 | 1.9927+00 | 1.9844+00 | 1.9079+00 | 1.7557+00 | 1.5540+00 | 1.3563+00 | 1.2242+00 | 1.2032+00 | 1.3034+00 |
| 1.4926+00 | 1.7072+00 | 1.8744+00 | 1.9391+00 | 1.8827+00 | 1.7282+00 | 1.5280+00 | 1.3409+00 | 1.2080+00 | 1.1376+00 |
| 1.1040+00 | 1.0625+00 | 9.7002-01 | 8.0497-01 | 5.7689-01 | 3.2187-01 | 8.7134-02 | -8.8267-02 | -1.8790-01 | -2.2165-01 |
| -2.1798-01 | -2.0918-01 | -2.1703-01 | -2.4542-01 | -2.8271-01 | -3.1169-01 | -3.2116-01 | -3.1264-01 | -2.9850-01 | -2.9226-01 |
| -2.9651-01 | -2.9515-01 | -2.5542-01 | -1.4033-01 | 7.3299-02 | 3.7906-01 | 7.3542-01 | 1.0743+00 | 1.3222+00 | 1.4249+00 |
| 1.3683+00 | 1.1835+00 | 9.3696-01 | 7.0698-01 | 5.5656-01 | 5.1329-01 | 5.6348-01 | 6.6228-01 | 7.5473-01 | 7.9856-01 |
| 7.7965-01 | 7.1382-01 | 6.3633-01 | 5.8371-01 | 5.7716-01 | 6.1421-01 | 6.7196-01 | 7.1927-01 | 7.3186-01 | 7.0311-01 |
| 6.4592-01 | 5.8527-01 | 5.4575-01 | 5.3997-01 | 5.6352-01 | 5.9839-01 | 6.2277-01 | 6.2236-01 | 5.9746-01 | 5.6264-01 |
| 5.3942-01 | 5.4549-01 | 5.8605-01 | 6.5118-01 | 7.2052-01 | 7.7288-01 | 7.9592-01 | 7.9146-01 | 7.7383-01 | 7.6227-01 |
| 7.7131-01 | 8.0365-01 | 8.4916-01 | 8.9022-01 | 9.1081-01 | 9.0465-01 | 8.7866-01 | 8.4979-01 | 8.3707-01 | 8.5271-01 |
| 8.9660-01 | 9.5699-01 | 1.0168+00 | 1.0627+00 | 1.0916+00 | 1.1125+00 | 1.1414+00 | 1.1925+00 | 1.2701+00 | 1.3648+00 |
| 1.4568+00 | 1.5244+00 | 1.5544+00 | 1.5485+00 | 1.5237+00 | 1.5049+00 | 1.5144+00 | 1.5615+00 | 1.6390+00 | 1.7264+00 |
| 1.7995+00 | 1.8417+00 | 1.8516+00 | 1.8427+00 | 1.8372+00 | 1.8545+00 | 1.9025+00 | 1.9735+00 | 2.0486+00 | 2.1075+00 |
| 2.1381+00 | 2.1431+00 | 2.1378+00 | 2.1418+00 | 2.1681+00 | 2.2147+00 | 2.2645+00 | 2.2925+00 | 2.2783+00 | 2.2172+00 |
| 2.1247+00 | 2.0306+00 | 1.9659+00 | 1.9470+00 | | | | | | |

SPAN STATION 4 CHORD STATION 4

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4.3393-01 | 4.3344-01 | 4.3306-01 | 4.3237-01 | 4.3102-01 | 4.2889-01 | 4.2614-01 | 4.2322-01 | 4.2066-01 | 4.1888-01 |
| 4.1803-01 | 4.1786-01 | 4.1794-01 | 4.1758-01 | 4.1636-01 | 4.1414-01 | 4.1118-01 | 4.0807-01 | 4.0551-01 | 4.0408-01 |
| 4.0405-01 | 4.0530-01 | 4.0742-01 | 4.0988-01 | 4.1219-01 | 4.1407-01 | 4.1548-01 | 4.1657-01 | 4.1752-01 | 4.1846-01 |
| 4.1941-01 | 4.2030-01 | 4.2102-01 | 4.2156-01 | 4.2195-01 | 4.2231-01 | 4.2271-01 | 4.2311-01 | 4.2334-01 | 4.2310-01 |
| 4.2213-01 | 4.2033-01 | 4.1785-01 | 4.1512-01 | 4.1271-01 | 4.1117-01 | 4.1084-01 | 4.1172-01 | 4.1348-01 | 4.1561-01 |
| 4.1760-01 | 4.1910-01 | 4.2000-01 | 4.2047-01 | 4.2074-01 | 4.2102-01 | 4.2136-01 | 4.2164-01 | 4.2167-01 | 4.2134-01 |
| 4.2071-01 | 4.2004-01 | 4.1975-01 | 4.2018-01 | 4.2147-01 | 4.2344-01 | 4.2563-01 | 4.2744-01 | 4.2839-01 | 4.2825-01 |
| 4.2722-01 | 4.2575-01 | 4.2442-01 | 4.2367-01 | 4.2364-01 | 4.2413-01 | 4.2470-01 | 4.2490-01 | 4.2446-01 | 4.2347-01 |
| 4.2229-01 | 4.2142-01 | 4.2127-01 | 4.2196-01 | 4.2324-01 | 4.2462-01 | 4.2555-01 | 4.2567-01 | 4.2497-01 | 4.2380-01 |
| 4.2271-01 | 4.2222-01 | 4.2261-01 | 4.2376-01 | 4.2526-01 | 4.2653-01 | 4.2711-01 | 4.2685-01 | 4.2599-01 | 4.2503-01 |
| 4.2455-01 | 4.2496-01 | 4.2632-01 | 4.2833-01 | 4.3046-01 | 4.3215-01 | 4.3303-01 | 4.3306-01 | 4.3253-01 | 4.3191-01 |
| 4.3163-01 | 4.3193-01 | 4.3276-01 | 4.3383-01 | 4.3472-01 | 4.3511-01 | 4.3487-01 | 4.3414-01 | 4.3327-01 | 4.3267-01 |
| 4.3269-01 | 4.3349-01 | 4.3498-01 | 4.3690-01 | 4.3888-01 | 4.4057-01 | 4.4171-01 | 4.4218-01 | 4.4205-01 | 4.4148-01 |
| 4.4072-01 | 4.4003-01 | 4.3964-01 | 4.3968-01 | 4.4013-01 | 4.4086-01 | 4.4159-01 | 4.4203-01 | 4.4190-01 | 4.4110-01 |
| 4.3969-01 | 4.3794-01 | 4.3621-01 | 4.3482-01 | | | | | | |

SPAN STATION 4 CHORD STATION 5

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -2.1187-01 | -2.1652-01 | -2.2478-01 | -2.3779-01 | -2.5464-01 | -2.7255-01 | -2.8774-01 | -2.9676-01 | -2.9763-01 | -2.9057-01 |
| -2.7778-01 | -2.6264-01 | -2.4854-01 | -2.3774-01 | -2.3089-01 | -2.2713-01 | -2.2488-01 | -2.2277-01 | -2.2041-01 | -2.1857-01 |
| -2.1876-01 | -2.2243-01 | -2.3002-01 | -2.4045-01 | -2.5121-01 | -2.5900-01 | -2.6070-01 | -2.5444-01 | -2.4007-01 | -2.1919-01 |
| -1.9461-01 | -1.6947-01 | -1.4648-01 | -1.2740-01 | -1.1300-01 | -1.0329-01 | -9.7962-02 | -9.6658-02 | -9.9063-02 | -1.0476-01 |

Figure 3. Sample Output - Continued.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -1.1300-01 | -1.2260-01 | -1.3203-01 | -1.3978-01 | -1.4481-01 | -1.4687-01 | -1.4660-01 | -1.4529-01 | -1.4434-01 | -1.4472-01 |
| -1.4657-01 | -1.4918-01 | -1.5123-01 | -1.5135-01 | -1.4860-01 | -1.4283-01 | -1.3467-01 | -1.2527-01 | -1.1588-01 | -1.0747-01 |
| -1.0056-01 | -9.5237-02 | -9.1342-02 | -8.8735-02 | -8.7408-02 | -8.7464-02 | -8.8970-02 | -9.1782-02 | -9.5471-02 | -9.9401-02 |
| -1.0295-01 | -1.0577-01 | -1.0793-01 | -1.0988-01 | -1.1225-01 | -1.1549-01 | -1.1962-01 | -1.2411-01 | -1.2804-01 | -1.3047-01 |
| -1.3080-01 | -1.2906-01 | -1.2595-01 | -1.2263-01 | -1.2031-01 | -1.1988-01 | -1.2164-01 | -1.2533-01 | -1.3032-01 | -1.3588-01 |
| -1.4149-01 | -1.4692-01 | -1.5213-01 | -1.5709-01 | -1.6161-01 | -1.6523-01 | -1.6739-01 | -1.6759-01 | -1.6568-01 | -1.6193-01 |
| -1.5699-01 | -1.5166-01 | -1.4657-01 | -1.4197-01 | -1.3770-01 | -1.3339-01 | -1.2876-01 | -1.2393-01 | -1.1953-01 | -1.1656-01 |
| -1.1609-01 | -1.1881-01 | -1.2468-01 | -1.3286-01 | -1.4189-01 | -1.5011-01 | -1.5610-01 | -1.5910-01 | -1.5909-01 | -1.5670-01 |
| -1.5293-01 | -1.4483-01 | -1.4520-01 | -1.4251-01 | -1.4089-01 | -1.4016-01 | -1.3996-01 | -1.3973-01 | -1.3878-01 | -1.3642-01 |
| -1.3213-01 | -1.2591-01 | -1.1844-01 | -1.1124-01 | -1.0637-01 | -1.0598-01 | -1.1157-01 | -1.2337-01 | -1.4011-01 | -1.5921-01 |
| -1.7752-01 | -1.9235-01 | -2.0239-01 | -2.0816-01 | | | | | | |

SPAN STATION 5 CHORD STATION 1

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7.8284+00 | 7.4669+00 | 7.0825+00 | 6.6284+00 | 6.1435+00 | 5.6457+00 | 5.1486+00 | 4.6601+00 | 4.1856+00 | 3.7305+00 |
| 3.3034+00 | 2.9159+00 | 2.5806+00 | 2.3068+00 | 2.0972+00 | 1.9456+00 | 1.8373+00 | 1.7523+00 | 1.6693+00 | 1.5712+00 |
| 1.4474+00 | 1.2960+00 | 1.1225+00 | 9.3754-01 | 7.5368-01 | 5.8227-01 | 4.3114-01 | 3.0340-01 | 1.9759-01 | 1.0888-01 |
| 3.1129-02 | -4.0720-02 | -1.0867-01 | -1.7058-01 | -2.2045-01 | -2.5008-01 | -2.5173-01 | -2.2082-01 | -1.5776-01 | -6.8160-02 |
| 3.8856-02 | 1.5364-01 | 2.6931-01 | 3.8407-01 | 5.0166-01 | 6.2962-01 | 7.7616-01 | 9.4656-01 | 1.1407+00 | 1.3525+00 |
| 1.5713+00 | 1.7846+00 | 1.9817+00 | 2.1550+00 | 2.3015+00 | 2.4213+00 | 2.5163+00 | 2.5884+00 | 2.6394+00 | 2.6708+00 |
| 2.6853+00 | 2.6874+00 | 2.6829+00 | 2.6777+00 | 2.6760+00 | 2.6778+00 | 2.6792+00 | 2.6728+00 | 2.6509+00 | 2.6081+00 |
| 2.5443+00 | 2.4647+00 | 2.3786+00 | 2.2964+00 | 2.2259+00 | 2.1706+00 | 2.1293+00 | 2.0977+00 | 2.0713+00 | 2.0482+00 |
| 2.0298+00 | 2.0210+00 | 2.0270+00 | 2.0516+00 | 2.0945+00 | 2.1516+00 | 2.2161+00 | 2.2807+00 | 2.3401+00 | 2.3919+00 |
| 2.4358+00 | 2.4729+00 | 2.5032+00 | 2.5258+00 | 2.5387+00 | 2.5410+00 | 2.5343+00 | 2.5235+00 | 2.5164+00 | 2.5210+00 |
| 2.5439+00 | 2.5876+00 | 2.6523+00 | 2.7352+00 | 2.8358+00 | 2.9565+00 | 3.1025+00 | 3.2794+00 | 3.4885+00 | 3.7230+00 |
| 3.9667+00 | 4.1969+00 | 4.3908+00 | 4.5346+00 | 4.6297+00 | 4.6947+00 | 4.7609+00 | 4.8617+00 | 5.0204+00 | 5.2403+00 |
| 5.5011+00 | 5.7655+00 | 5.9916+00 | 6.1497+00 | 6.2352+00 | 6.2737+00 | 6.3151+00 | 6.4185+00 | 6.6323+00 | 6.9767+00 |
| 7.4351+00 | 7.9564+00 | 8.4693+00 | 8.9017+00 | 9.2003+00 | 9.3431+00 | 9.3417+00 | 9.2330+00 | 9.0638+00 | 8.8754+00 |
| 8.6912+00 | 8.5131+00 | 8.3254+00 | 8.1042+00 | | | | | | |

SPAN STATION 5 CHORD STATION 2

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1.7821+00 | 1.5385+00 | 1.3153+00 | 1.1998+00 | 1.2601+00 | 1.5173+00 | 1.9310+00 | 2.4073+00 | 2.8262+00 | 3.0791+00 |
| 3.1032+00 | 2.8997+00 | 2.5302+00 | 2.0930+00 | 1.6887+00 | 1.3888+00 | 1.2172+00 | 1.1518+00 | 1.1413+00 | 1.1303+00 |
| 1.0809+00 | 9.8365-01 | 8.5375-01 | 7.1816-01 | 5.9947-01 | 5.0540-01 | 4.2789-01 | 3.5112-01 | 2.6317-01 | 1.6467-01 |
| 6.9368-02 | -3.7753-03 | -4.3098-02 | -5.4672-02 | -6.4730-02 | -1.1181-01 | -2.3125-01 | -4.3863-01 | -7.1962-01 | -1.0313+00 |
| -1.3151+00 | -1.5167+00 | -1.6042+00 | -1.5781+00 | -1.4684+00 | -1.3207+00 | -1.1774+00 | -1.0620+00 | -9.7247-01 | -8.8671-01 |
| -7.7636-01 | -6.2255-01 | -4.2662-01 | -2.1114-01 | -1.1069-02 | 1.4057-01 | 2.2610-01 | 2.4972-01 | 2.3477-01 | 2.1321-01 |
| 2.1241-01 | 2.4489-01 | 3.0544-01 | 3.7599-01 | 4.3545-01 | 4.6974-01 | 4.7737-01 | 4.6840-01 | 4.5810-01 | 4.5857-01 |
| 4.7283-01 | 4.9397-01 | 5.0957-01 | 5.0890-01 | 4.8912-01 | 4.5733-01 | 4.2759-01 | 4.1431-01 | 4.2586-01 | 4.5937-01 |
| 5.0502-01 | 5.4852-01 | 5.7955-01 | 5.9635-01 | 6.0631-01 | 6.2182-01 | 6.5359-01 | 7.0469-01 | 7.6833-01 | 8.3043-01 |
| 8.7583-01 | 8.9511-01 | 8.8881-01 | 8.6699-01 | 8.4434-01 | 8.3344-01 | 8.3920-01 | 8.5731-01 | 8.7728-01 | 8.8862-01 |
| 8.8689-01 | 8.7681-01 | 8.7077-01 | 8.8343-01 | 9.2506-01 | 9.9678-01 | 1.0899+00 | 1.1896+00 | 1.2813+00 | 1.3559+00 |
| 1.4128+00 | 1.4578+00 | 1.4988+00 | 1.5407+00 | 1.5831+00 | 1.6210+00 | 1.6496+00 | 1.6683+00 | 1.6834+00 | 1.7061+00 |
| 1.7473+00 | 1.8113+00 | 1.8913+00 | 1.9712+00 | 2.0316+00 | 2.0591+00 | 2.0533+00 | 2.0295+00 | 2.0124+00 | 2.0260+00 |
| 2.0814+00 | 2.1701+00 | 2.2660+00 | 2.3352+00 | 2.3511+00 | 2.3069+00 | 2.2201+00 | 2.1256+00 | 2.0597+00 | 2.0423+00 |
| 2.0648+00 | 2.0916+00 | 2.0739+00 | 1.9728+00 | | | | | | |

SPAN STATION 5 CHORD STATION 3

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -5.7085-01 | -7.3682-01 | -8.5335-01 | -9.2409-01 | -9.8502-01 | -1.0934+00 | -1.3040+00 | -1.6424+00 | -2.0889+00 | -2.5612+00 |
| -2.9634+00 | -3.1882+00 | -3.1683+00 | -2.8991+00 | -2.4430+00 | -1.9116+00 | -1.4305+00 | -1.0999+00 | -9.6583-01 | -1.0117+00 |
| -1.1721+00 | -1.3623+00 | -1.5114+00 | -1.5866+00 | -1.5986+00 | -1.5904+00 | -1.6124+00 | -1.6987+00 | -1.8512+00 | -2.0401+00 |
| -2.2179+00 | -2.3396+00 | -2.3810+00 | -2.3464+00 | -2.2633+00 | -2.1689+00 | -2.0927+00 | -2.0460+00 | -2.0205+00 | -1.9971+00 |
| -1.9594+00 | -1.9048+00 | -1.8484+00 | -1.8168+00 | -1.8356+00 | -1.9158+00 | -2.0454+00 | -2.1918+00 | -2.3115+00 | -2.3656+00 |
| -2.3335+00 | -2.2191+00 | -2.0477+00 | -1.8555+00 | -1.6760+00 | -1.5291+00 | -1.4176+00 | -1.3306+00 | -1.2517+00 | -1.1684+00 |
| -1.0776+00 | -9.8502-01 | -9.0061-01 | -8.3218-01 | -7.8066-01 | -7.3965-01 | -6.9908-01 | -6.5084-01 | -5.9336-01 | -5.3259-01 |
| -4.7901-01 | -4.4210-01 | -4.2527-01 | -4.2359-01 | -4.2585-01 | -4.1963-01 | -3.9702-01 | -3.5821-01 | -3.1100-01 | -2.6648-01 |
| -2.3424-01 | -2.1581-01 | -2.0559-01 | -1.9281-01 | -1.6728-01 | -1.2467-01 | -6.9098-02 | -1.1508-02 | 3.5240-02 | 6.2248-02 |

Figure 3. Sample Output - Continued.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6.8571-02 | 6.1399-02 | 5.2369-02 | 5.1859-02 | 6.4082-02 | 8.5377-02 | 1.0651-01 | 1.1780-01 | 1.1447-01 | 9.9557-02 |
| 8.2836-02 | 7.6358-02 | 8.8735-02 | 1.2107-01 | 1.6658-01 | 2.1404-01 | 2.5337-01 | 2.8048-01 | 2.9880-01 | 3.1676-01 |
| 3.4239-01 | 3.7791-01 | 4.1730-01 | 4.4830-01 | 4.5829-01 | 4.4119-01 | 4.0185-01 | 3.5546-01 | 3.2165-01 | 3.1587-01 |
| 3.4188-01 | 3.8914-01 | 4.3676-01 | 4.6252-01 | 4.5296-01 | 4.0996-01 | 3.5044-01 | 2.9901-01 | 2.7680-01 | 2.9146-01 |
| 3.3317-01 | 3.7869-01 | 4.0173-01 | 3.8498-01 | 3.2798-01 | 2.4699-01 | 1.6660-01 | 1.0704-01 | 7.3142-02 | 5.0771-02 |
| 1.2837-02 | -6.7409-02 | -2.0202-01 | -3.8014-01 | | | | | | |

SPAN STATION 5 CHORD STATION 4

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -1.4346+00 | -1.4987+00 | -1.5744+00 | -1.6608+00 | -1.7511+00 | -1.8350+00 | -1.9025+00 | -1.9476+00 | -1.9716+00 | -1.9823+00 |
| -1.9915+00 | -2.0107+00 | -2.0463+00 | -2.0976+00 | -2.1573+00 | -2.2142+00 | -2.2578+00 | -2.2819+00 | -2.2862+00 | -2.2751+00 |
| -2.2544+00 | -2.2277+00 | -2.1935+00 | -2.1455+00 | -2.0751+00 | -1.9752+00 | -1.8444+00 | -1.6891+00 | -1.5220+00 | -1.3593+00 |
| -1.2161+00 | -1.1020+00 | -1.0202+00 | -9.6749-01 | -9.3769-01 | -9.2500-01 | -9.2643-01 | -9.4226-01 | -9.7438-01 | -1.0235+00 |
| -1.0866+00 | -1.1562+00 | -1.2215+00 | -1.2714+00 | -1.2981+00 | -1.2993+00 | -1.2787+00 | -1.2441+00 | -1.2046+00 | -1.1669+00 |
| -1.1338+00 | -1.1042+00 | -1.0748+00 | -1.0428+00 | -1.0073+00 | -9.7057-01 | -9.3653-01 | -9.0873-01 | -8.8839-01 | -8.7339-01 |
| -8.5899-01 | -8.3980-01 | -8.1219-01 | -7.7603-01 | -7.3487-01 | -6.9462-01 | -6.6110-01 | -6.3771-01 | -6.2421-01 | -6.1703-01 |
| -6.1100-01 | -6.0165-01 | -5.8699-01 | -5.6811-01 | -5.4824-01 | -5.3099-01 | -5.1842-01 | -5.1000-01 | -5.0285-01 | -4.9307-01 |
| -4.7761-01 | -4.5563-01 | -4.2888-01 | -4.0091-01 | -3.7553-01 | -3.5531-01 | -3.4078-01 | -3.3070-01 | -3.2313-01 | -3.1672-01 |
| -3.1155-01 | -3.0907-01 | -3.1111-01 | -3.1858-01 | -3.3052-01 | -3.4399-01 | -3.5499-01 | -3.5996-01 | -3.5732-01 | -3.4805-01 |
| -3.3529-01 | -3.2289-01 | -3.1373-01 | -3.0849-01 | -3.0549-01 | -3.0170-01 | -2.9445-01 | -2.8307-01 | -2.6964-01 | -2.5851-01 |
| -2.5480-01 | -2.6240-01 | -2.8246-01 | -3.1295-01 | -3.4940-01 | -3.8655-01 | -4.2014-01 | -4.4813-01 | -4.7091-01 | -4.9053-01 |
| -5.0951-01 | -5.2972-01 | -5.5183-01 | -5.7556-01 | -6.0024-01 | -6.2539-01 | -6.5092-01 | -6.7681-01 | -7.0263-01 | -7.2719-01 |
| -7.4890-01 | -7.6664-01 | -7.8097-01 | -7.9480-01 | -8.1327-01 | -8.4230-01 | -8.8655-01 | -9.4734-01 | -1.0217+00 | -1.1032+00 |
| -1.1837+00 | -1.2569+00 | -1.3207+00 | -1.3777+00 | | | | | | |

SPAN STATION 5 CHORD STATION 5

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| -7.7242-01 | -7.7638-01 | -7.7852-01 | -7.7857-01 | -7.7621-01 | -7.7129-01 | -7.6410-01 | -7.5546-01 | -7.4659-01 | -7.3875-01 |
| -7.3276-01 | -7.2857-01 | -7.2510-01 | -7.2054-01 | -7.1293-01 | -7.0092-01 | -6.8448-01 | -6.6510-01 | -6.4550-01 | -6.2882-01 |
| -6.1758-01 | -6.1265-01 | -6.1280-01 | -6.1484-01 | -6.1436-01 | -6.0691-01 | -5.8926-01 | -5.6022-01 | -5.2101-01 | -4.7495-01 |
| -4.2674-01 | -3.8144-01 | -3.4360-01 | -3.1656-01 | -3.0207-01 | -3.0028-01 | -3.0981-01 | -3.2808-01 | -3.5165-01 | -3.7671-01 |
| -3.9959-01 | -4.1736-01 | -4.2830-01 | -4.3220-01 | -4.3033-01 | -4.2503-01 | -4.1909-01 | -4.1492-01 | -4.1402-01 | -4.1667-01 |
| -4.2205-01 | -4.2867-01 | -4.3500-01 | -4.3987-01 | -4.4278-01 | -4.4373-01 | -4.4300-01 | -4.4082-01 | -4.3719-01 | -4.3196-01 |
| -4.2511-01 | -4.1702-01 | -4.0863-01 | -4.0134-01 | -3.9658-01 | -3.9534-01 | -3.9775-01 | -4.0291-01 | -4.0918-01 | -4.1468-01 |
| -4.1794-01 | -4.1836-01 | -4.1629-01 | -4.1283-01 | -4.0921-01 | -4.0628-01 | -4.0415-01 | -4.0220-01 | -3.9946-01 | -3.9514-01 |
| -3.8909-01 | -3.8193-01 | -3.7490-01 | -3.6934-01 | -3.6614-01 | -3.6543-01 | -3.6650-01 | -3.6817-01 | -3.6932-01 | -3.6932-01 |
| -3.6829-01 | -3.6695-01 | -3.6620-01 | -3.6664-01 | -3.6820-01 | -3.7016-01 | -3.7140-01 | -3.7100-01 | -3.6865-01 | -3.6489-01 |
| -3.6095-01 | -3.5830-01 | -3.5806-01 | -3.6055-01 | -3.6525-01 | -3.7101-01 | -3.7665-01 | -3.8147-01 | -3.8563-01 | -3.9012-01 |
| -3.9634-01 | -4.0554-01 | -4.1829-01 | -4.3419-01 | -4.5204-01 | -4.7022-01 | -4.8730-01 | -5.0248-01 | -5.1577-01 | -5.2784-01 |
| -5.3962-01 | -5.5180-01 | -5.6455-01 | -5.7740-01 | -5.8950-01 | -5.9990-01 | -6.0802-01 | -6.1383-01 | -6.1787-01 | -6.2110-01 |
| -6.2460-01 | -6.2932-01 | -6.3589-01 | -6.4459-01 | -6.5537-01 | -6.6794-01 | -6.8186-01 | -6.9655-01 | -7.1134-01 | -7.2554-01 |
| -7.3853-01 | -7.4984-01 | -7.5925-01 | -7.6673-01 | | | | | | |

Figure 3. Sample Output - Continued.

```
XLO XLM XMM

   .00
   .00      .00     .00     .00     .00     .00     .00     .00     .00     .00
   .00      .00     .00     .00     .00     .00     .00     .00     .00     .00
   .00      .00     .00     .00     .00     .00     .00     .00     .00     .00
   .00      .00
  3.37
 -4.87     2.88    1.00    -.50    -.65    -.14     .00    -.02     .13    -.20
  -.08     -.04     .02    -.01     .12     .05    3.99   -4.07    1.96    1.15
   .56      .09     .18    -.14     .07     .03     .01     .08     .15     .01
   .01      .01
 15.68
   .47     6.93    3.43   -1.66    -.09     .46    -.30    -.07     .30    -.14
  -.28      .22     .23    -.21    -.04     .14    1.41   -4.23    2.58    1.21
  -.42     -.35     .54    -.25    -.02     .28    -.04    -.15     .22     .11
  -.17      .04
 17.46
  6.29     6.77    2.89    -.89     .32     .58     .50    -.01    -.71     .12
   .00     -.47     .25     .52    -.18    -.17     .63   -3.45    1.80     .41
  -.10     -.87     .47     .87    -.20    -.52     .44     .04    -.53     .17
   .35     -.15
 18.99
  8.33     5.58    1.44   -1.22     .08     .14    -.27     .42     .30    -.25
  -.10      .32     .10     .00    -.04    -.45   -4.66   -4.01    1.31    -.07
  -.72     -.54     .00    -.20     .17     .12    -.13     .12     .24     .01
   .22      .16
 -3.70
  1.49     3.25    -.08     .92    1.22    -.29    -.01     .51    -.13    -.28
  -.39     -.28     .09     .03     .18     .27  -14.05   -4.43   -1.97   -2.28
  -.33     -.80    -.40     .26     .38     .23     .34     .07    -.05    -.28
  -.43     -.17
   .00
   .00      .00     .00     .00     .00     .00     .00     .00     .00     .00
   .00      .00     .00     .00     .00     .00     .00     .00     .00     .00
   .00      .00     .00     .00     .00     .00     .00     .00     .00     .00
   .00      .00

B01    .851500+01  B1    .178780+01  B11   -.915460+01  CHORD    .182000+02  OMEGA    .204000+03  BLADES   5.

RADIUS AT START OF TWIST     .740000+02
```

BLADE SECTION LOADING

| RADIUS | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|
| AZIMUTH | | .000000 | .148800+03 | .279000+03 | .316200+03 | .353400+03 | .364560+03 | .372000+03 | |
| 1 | .0 | .000000 | .106036+01 | .250871+02 | .332642+02 | .333852+02 | .279480+01 | .000000 | |
| 2 | 2.5 | .000000 | .165807+01 | .252873+02 | .332935+02 | .331405+02 | .629414-00 | .000000 | |
| 3 | 5.0 | .000000 | .219971+01 | .253528+02 | .332073+02 | .327594+02 | -.148130+01 | .000000 | |
| 4 | 7.5 | .000000 | .265998+01 | .252857+02 | .329744+02 | .320694+02 | -.336203+01 | .000000 | |
| 5 | 10.0 | .000000 | .303862+01 | .251021+02 | .325735+02 | .309940+02 | -.495501+01 | .000000 | |
| 6 | 12.5 | .000000 | .334723+01 | .248204+02 | .320037+02 | .296041+02 | -.635305+01 | .000000 | |
| 7 | 15.0 | .000000 | .359401+01 | .244525+02 | .312838+02 | .281075+02 | -.776272+01 | .000000 | |
| 8 | 17.5 | .000000 | .377395+01 | .240007+02 | .304417+02 | .267758+02 | -.940912+01 | .000000 | |
| 9 | 20.0 | .000000 | .386849+01 | .234617+02 | .294982+02 | .258384+02 | -.114211+02 | .000000 | |
| 10 | 22.5 | .000000 | .385404+01 | .228336+02 | .284548+02 | .253866+02 | -.137470+02 | .000000 | |
| 11 | 25.0 | .000000 | .371428+01 | .221213+02 | .272944+02 | .253306+02 | -.161410+02 | .000000 | |

Figure 3. Sample Output - Continued.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | 27.5 | .000000 | .344982+01 | .213366+02 | .259991+02 | .2543[illegible]0+02 | -.182316+02 | .000000 |
| 13 | 30.0 | .000000 | .308021+01 | .204927+02 | .245769+02 | .253908+02 | -.196501+02 | .000000 |
| 14 | 32.5 | .000000 | .263719+01 | .195970+02 | .230869+02 | .249729+02 | -.201696+02 | .000000 |
| 15 | 35.0 | .000000 | .215249+01 | .186460+02 | .216450+02 | .240915+02 | -.197988+02 | .000000 |
| 16 | 37.5 | .000000 | .164613+01 | .176278+02 | .204019+02 | .228397+02 | -.187929+02 | .000000 |
| 17 | 40.0 | .000000 | .112094+01 | .165313+02 | .194950+02 | .214411+02 | -.175737+02 | .000000 |
| 18 | 42.5 | .000000 | .566111-00 | .153574+02 | .189912+02 | .201481+02 | -.165890+02 | .000000 |
| 19 | 45.0 | .000000 | -.316421-01 | .141274+02 | .188421+02 | .191289+02 | -.161658+02 | .000000 |
| 20 | 47.5 | .000000 | -.674517-00 | .128811+02 | .188768+02 | .183956+02 | -.164109+02 | .000000 |
| 21 | 50.0 | .000000 | -.134398+01 | .116648+02 | .188412+02 | .178010+02 | -.171951+02 | .000000 |
| 22 | 52.5 | .000000 | -.199980+01 | .105126+02 | .184753+02 | .171068+02 | -.182235+02 | .000000 |
| 23 | 55.0 | .000000 | -.258856+01 | .943093+01 | .176039+02 | .160928+02 | -.191579+02 | .000000 |
| 24 | 57.5 | .000000 | -.305827+01 | .839519+01 | .162045+02 | .146583+02 | -.197430+02 | .000000 |
| 25 | 60.0 | .000000 | -.337270+01 | .736281+01 | .144225+02 | .128731+02 | -.198852+02 | .000000 |
| 26 | 62.5 | .000000 | -.351955+01 | .630024+01 | .125255+02 | .109570+02 | -.196595+02 | .000000 |
| 27 | 65.0 | .000000 | -.350887+01 | .521250+01 | .108070+02 | .919680+01 | -.192489+02 | .000000 |
| 28 | 67.5 | .000000 | -.336301+01 | .416107+01 | .947868+01 | .783959+01 | -.188487+02 | .000000 |
| 29 | 70.0 | .000000 | -.310294+01 | .325861+01 | .859301+01 | .700525+01 | -.185793+02 | .000000 |
| 30 | 72.5 | .000000 | -.273734+01 | .263789+01 | .803050+01 | .665534+01 | -.184464+02 | .000000 |
| 31 | 75.0 | .000000 | -.225995+01 | .240388+01 | .756115+01 | .662653+01 | -.183592+02 | .000000 |
| 32 | 77.5 | .000000 | -.165613+01 | .258749+01 | .695815+01 | .670988+01 | -.181951+02 | .000000 |
| 33 | 80.0 | .000000 | -.915862-00 | .312148+01 | .611872+01 | .673824+01 | -.178761+02 | .000000 |
| 34 | 82.5 | .000000 | -.467672-01 | .385275+01 | .514044+01 | .664336+01 | -.174[illegible]99+02 | .000000 |
| 35 | 85.0 | .000000 | .919450-00 | .459139+01 | .431622+01 | .646117+01 | -.169425+02 | .000000 |
| 36 | 87.5 | .000000 | .193109+01 | .518153+01 | .404222+01 | .628891+01 | -.166113+02 | .000000 |
| 37 | 90.0 | .000000 | .293047+01 | .556790+01 | .466840+01 | .622039+01 | -.165716+02 | .000000 |
| 38 | 92.5 | .000000 | .387266+01 | .583082+01 | .634729+01 | .629407+01 | -.168801+02 | .000000 |
| 39 | 95.0 | .000000 | .474142+01 | .617224+01 | .894088+01 | .648001+01 | -.174766+02 | .000000 |
| 40 | 97.5 | .000000 | .555529+01 | .685332+01 | .120266+02 | .671079+01 | -.182050+02 | .000000 |
| 41 | 100.0 | .000000 | .636062+01 | .810280+01 | .150072+02 | .693791+01 | -.188747+02 | .000000 |
| 42 | 102.5 | .000000 | .721342+01 | .100283+02 | .172898+02 | .718151+01 | -.193335+02 | .000000 |
| 43 | 105.0 | .000000 | .815639+01 | .125636+02 | .184721+02 | .754384+01 | -.195201+02 | .000000 |
| 44 | 107.5 | .000000 | .919976+01 | .154717+02 | .184695+02 | .817416+01 | -.194743+02 | .000000 |
| 45 | 110.0 | .000000 | .103129+02 | .184062+02 | .175372+02 | .919770+01 | -.193016+02 | .000000 |
| 46 | 112.5 | .000000 | .114304+02 | .210091+02 | .161809+02 | .106405+02 | -.191099+02 | .000000 |
| 47 | 115.0 | .000000 | .124697+02 | .230108+02 | .149879+02 | .123870+02 | -.189493+02 | .000000 |
| 48 | 117.5 | .000000 | .133548+02 | .242999+02 | .144392+02 | .141951+02 | -.187807+02 | .000000 |
| 49 | 120.0 | .000000 | .140375+02 | .249382+02 | .147690+02 | .157674+02 | -.184888+02 | .000000 |
| 50 | 122.5 | .000000 | .145083+02 | .251190+02 | .159146+02 | .168528+02 | -.179329+02 | .000000 |
| 51 | 125.0 | .000000 | .147955+02 | .250881+02 | .175691+02 | .173373+02 | -.170122+02 | .000000 |
| 52 | 127.5 | .000000 | .149522+02 | .250573+02 | .193085+02 | .172840+02 | -.157173+02 | .000000 |
| 53 | 130.0 | .000000 | .150384+02 | .251420+02 | .207422+02 | .169072+02 | -.141456+02 | .000000 |
| 54 | 132.5 | .000000 | .151027+02 | .253430+02 | .216314+02 | .164869+02 | -.124739+02 | .000000 |
| 55 | 135.0 | .000000 | .151724+02 | .255727+02 | .219384+02 | .162620+02 | -.109002+02 | .000000 |
| 56 | 137.5 | .000000 | .152513+02 | .257120+02 | .217979+02 | .163442+02 | -.957932+01 | .000000 |
| 57 | 140.0 | .000000 | .153269+02 | .256696+02 | .214321+02 | .166875+02 | -.857757+01 | .000000 |
| 58 | 142.5 | .000000 | .153814+02 | .254222+02 | .210509+02 | .171237+02 | -.786310+01 | .000000 |
| 59 | 145.0 | .000000 | .154022+02 | .250188+02 | .207764+02 | .174459+02 | -.733263+01 | .000000 |
| 60 | 147.5 | .000000 | .153867+02 | .245538+02 | .206177+02 | .175016+02 | -.686043+01 | .000000 |
| 61 | 150.0 | .000000 | .153415+02 | .241229+02 | .204971+02 | .172565+02 | -.634783+01 | .000000 |
| 62 | 152.5 | .000000 | .152758+02 | .237814+02 | .203082+02 | .168012+02 | -.575405+01 | .000000 |
| 63 | 155.0 | .000000 | .151929+02 | .235244+02 | .199762+02 | .163040+02 | -.509877+01 | .000000 |
| 64 | 157.5 | .000000 | .150831+02 | .232942+02 | .194922+02 | .159308+02 | -.444014+01 | .000000 |
| 65 | 160.0 | .000000 | .149226+02 | .230089+02 | .189111+02 | .157715+02 | -.384187+01 | .000000 |
| 66 | 162.5 | .000000 | .146775+02 | .225998+02 | .183183+02 | .158046+02 | -.334534+01 | .000000 |
| 67 | 165.0 | .000000 | .143134+02 | .220382+02 | .177846+02 | .159135+02 | -.295812+01 | .000000 |
| 68 | 167.5 | .000000 | .138063+02 | .213438+02 | .173320+02 | .159446+02 | -.266088+01 | .000000 |
| 69 | 170.0 | .000000 | .131517+02 | .205712+02 | .169258+02 | .157787+02 | -.242544+01 | .000000 |
| 70 | 172.5 | .000000 | .123693+02 | .197838+02 | .164949+02 | .153832+02 | -.223269+01 | .000000 |
| 71 | 175.0 | .000000 | .115003+02 | .190284+02 | .159686+02 | .148214+02 | -.208062+01 | .000000 |
| 72 | 177.5 | .000000 | .105994+02 | .183212+02 | .153117+02 | .142183+02 | -.197917+01 | .000000 |
| 73 | 180.0 | .000000 | .972221+01 | .176504+02 | .145424+02 | .137017+02 | -.193639+01 | .000000 |

Figure 3. Sample Output - Continued.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 74 | 182.5 | .000000 | .891287+01 | .169929+02 | .137249+02 | .133453+02 | -.194457+01 | .000000 |
| 75 | 185.0 | .000000 | .819412+01 | .163348+02 | .129437+02 | .131427+02 | -.197507+01 | .000000 |
| 76 | 187.5 | .000000 | .756373+01 | .156853+02 | .122704+02 | .130214+02 | -.198508+01 | .000000 |
| 77 | 190.0 | .000000 | .699768+01 | .150771+02 | .117404+02 | .128870+02 | -.193322+01 | .000000 |
| 78 | 192.5 | .000000 | .645925+01 | .145546+02 | .113484+02 | .126772+02 | -.179579+01 | .000000 |
| 79 | 195.0 | .000000 | .591125+01 | .141541+02 | .110620+02 | .123955+02 | -.157526+01 | .000000 |
| 80 | 197.5 | .000000 | .532768+01 | .138882+02 | .108456+02 | .121121+02 | -.129623+01 | .000000 |
| 81 | 200.0 | .000000 | .470121+01 | .137395+02 | .106816+02 | .119289+02 | -.991110-00 | .000000 |
| 82 | 202.5 | .000000 | .404431+01 | .136684+02 | .105785+02 | .119298+02 | -.682671-00 | .000000 |
| 83 | 205.0 | .000000 | .338385+01 | .136282+02 | .105622+02 | .121383+02 | -.372672-00 | .000000 |
| 84 | 207.5 | .000000 | .275126+01 | .135830+02 | .106569+02 | .125041+02 | -.425769-01 | .000000 |
| 85 | 210.0 | .000000 | .217189+01 | .135174+02 | .108643+02 | .129246+02 | .333735-00 | .000000 |
| 86 | 212.5 | .000000 | .165734+01 | .134349+02 | .111534+02 | .132902+02 | .771576-00 | .000000 |
| 87 | 215.0 | .000000 | .120336+01 | .133477+02 | .114659+02 | .135315+02 | .126076+01 | .000000 |
| 88 | 217.5 | .000000 | .793834-00 | .132619+02 | .117339+02 | .136452+02 | .176242+01 | .000000 |
| 89 | 220.0 | .000000 | .409015-00 | .131676+02 | .119031+02 | .136882+02 | .221961+01 | .000000 |
| 90 | 222.5 | .000000 | .344755-01 | .130380+02 | .119502+02 | .137420+02 | .257736+01 | .000000 |
| 91 | 225.0 | .000000 | -.332888-00 | .128395+02 | .118863+02 | .138680+02 | .280305+01 | .000000 |
| 92 | 227.5 | .000000 | -.684157-00 | .125459+02 | .117462+02 | .140739+02 | .289802+01 | .000000 |
| 93 | 230.0 | .000000 | -.100311+01 | .121514+02 | .115697+02 | .143094+02 | .289518+01 | .000000 |
| 94 | 232.5 | .000000 | -.127411+01 | .116749+02 | .113817+02 | .144926+02 | .284440+01 | .000000 |
| 95 | 235.0 | .000000 | -.148972+01 | .111533+02 | .111832+02 | .145528+02 | .279260+01 | .000000 |
| 96 | 237.5 | .000000 | -.165444+01 | .106279+02 | .109545+02 | .144703+02 | .276808+01 | .000000 |
| 97 | 240.0 | .000000 | -.178323+01 | .101292+02 | .106694+02 | .142908+02 | .277568+01 | .000000 |
| 98 | 242.5 | .000000 | -.189528+01 | .966869+01 | .103137+02 | .141088+02 | .280410+01 | .000000 |
| 99 | 245.0 | .000000 | -.200603+01 | .924092+01 | .989813+01 | .140271+02 | .284051+01 | .000000 |
| 100 | 247.5 | .000000 | -.212102+01 | .883471+01 | .946149+01 | .141134+02 | .288443+01 | .000000 |
| 101 | 250.0 | .000000 | -.223434+01 | .844817+01 | .906213+01 | .143738+02 | .295369+01 | .000000 |
| 102 | 252.5 | .000000 | -.233230+01 | .809914+01 | .876277+01 | .147581+02 | .307993+01 | .000000 |
| 103 | 255.0 | .000000 | -.240055+01 | .782542+01 | .861489+01 | .151928+02 | .329639+01 | .000000 |
| 104 | 257.5 | .000000 | -.243119+01 | .767352+01 | .864863+01 | .156248+02 | .362482+01 | .000000 |
| 105 | 260.0 | .000000 | -.242647+01 | .768023+01 | .887054+01 | .160540+02 | .406803+01 | .000000 |
| 106 | 262.5 | .000000 | -.239730+01 | .785515+01 | .926748+01 | .165356+02 | .461113+01 | .000000 |
| 107 | 265.0 | .000000 | -.235745+01 | .817207+01 | .981266+01 | .171503+02 | .522932+01 | .000000 |
| 108 | 267.5 | .000000 | -.231632+01 | .857382+01 | .104701+02 | .179558+02 | .589635+01 | .000000 |
| 109 | 270.0 | .000000 | -.227410+01 | .898914+01 | .111960+02 | .189429+02 | .658773+01 | .000000 |
| 110 | 272.5 | .000000 | -.222197+01 | .935530+01 | .119396+02 | .200214+02 | .727672+01 | .000000 |
| 111 | 275.0 | .000000 | -.214751+01 | .963742+01 | .126459+02 | .210440+02 | .792624+01 | .000000 |
| 112 | 277.5 | .000000 | -.204262+01 | .983734+01 | .132639+02 | .218621+02 | .848427+01 | .000000 |
| 113 | 280.0 | .000000 | -.190976+01 | .998898+01 | .137598+02 | .223889+02 | .888989+01 | .000000 |
| 114 | 282.5 | .000000 | -.176272+01 | .101431+02 | .141301+02 | .226414+02 | .909192+01 | .000000 |
| 115 | 285.0 | .000000 | -.162049+01 | .103480+02 | .144089+02 | .227403+02 | .907483+01 | .000000 |
| 116 | 287.5 | .000000 | -.149651+01 | .106343+02 | .146637+02 | .228663+02 | .887969+01 | .000000 |
| 117 | 290.0 | .000000 | -.138828+01 | .110087+02 | .149787+02 | .231889+02 | .860715+01 | .000000 |
| 118 | 292.5 | .000000 | -.127293+01 | .114572+02 | .154284+02 | .237996+02 | .839497+01 | .000000 |
| 119 | 295.0 | .000000 | -.111268+01 | .119559+02 | .160530+02 | .246769+02 | .837382+01 | .000000 |
| 120 | 297.5 | .000000 | -.869578-00 | .124818+02 | .168427+02 | .256998+02 | .861633+01 | .000000 |
| 121 | 300.0 | .000000 | -.524579-00 | .130194+02 | .177399+02 | .267023+02 | .910104+01 | .000000 |
| 122 | 302.5 | .000000 | -.931402-01 | .135618+02 | .186581+02 | .275454+02 | .970978+01 | .000000 |
| 123 | 305.0 | .000000 | .370356-00 | .141062+02 | .195114+02 | .281740+02 | .102650+02 | .000000 |
| 124 | 307.5 | .000000 | .783219-00 | .146500+02 | .202442+02 | .286341+02 | .105970+02 | .000000 |
| 125 | 310.0 | .000000 | .105814+01 | .151879+02 | .208483+02 | .290446+02 | .106157+02 | .000000 |
| 126 | 312.5 | .000000 | .113227+01 | .157154+02 | .213634+02 | .295369+02 | .103574+02 | .000000 |
| 127 | 315.0 | .000000 | .990984-00 | .162334+02 | .218593+02 | .301927+02 | .998419+01 | .000000 |
| 128 | 317.5 | .000000 | .676661-00 | .167530+02 | .224099+02 | .310075+02 | .973047+01 | .000000 |
| 129 | 320.0 | .000000 | .277974-00 | .172943+02 | .230673+02 | .318962+02 | .981561+01 | .000000 |
| 130 | 322.5 | .000000 | -.975471-01 | .178804+02 | .238478+02 | .327368+02 | .103546+02 | .000000 |
| 131 | 325.0 | .000000 | -.358291-00 | .185256+02 | .247316+02 | .334290+02 | .113037+02 | .000000 |
| 132 | 327.5 | .000000 | -.458084-00 | .192259+02 | .256758+02 | .339392+02 | .124644+02 | .000000 |
| 133 | 330.0 | .000000 | -.409458-00 | .199540+02 | .266327+02 | .343097+02 | .135465+02 | .000000 |
| 134 | 332.5 | .000000 | -.275629-00 | .206651+02 | .275639+02 | .346285+02 | .142672+02 | .000000 |
| 135 | 335.0 | .000000 | -.144173-00 | .213105+02 | .284478+02 | .349751+02 | .144463+02 | .000000 |

Figure 3. Sample Output - Continued.

```
136  337.5    .000000    -.923152-01    .218543+02    .292756+02    .353705+02    .140602+02    .000000
137  340.0    .000000    -.156881-00    .222878+02    .300437+02    .357583+02    .132330+02    .000000
138  342.5    .000000    -.319983-00    .226324+02    .307460+02    .360266+02    .121702+02    .000000
139  345.0    .000000    -.515339-00    .229320+02    .313715+02    .360626+02    .110650+02    .000000
140  347.5    .000000    -.652163-00    .232359+02    .319080+02    .358127+02    .100164+02    .000000
141  350.0    .000000    -.647071-00    .235792+02    .323484+02    .353173+02    .899642+01    .000000
142  352.5    .000000    -.451864-00    .239690+02    .326951+02    .347002+02    .787797+01    .000000
143  355.0    .000000    -.673450-01    .243818+02    .329580+02    .341157+02    .651026+01    .000000
144  357.5    .000000     .460734-00    .247717+02    .331474+02    .336745+02    .480529+01    .000000
145  360.0    .000000     .106036+01    .250871+02    .332642+02    .333852+02    .279480+01    .000000
FIELD POINT          RADIUS    .154500+04     AZIMUTH      .169900+03    ELEVATION    -.232000+02
                   HARMONIC         SOUND PRESSURE               SPL
                          1           .30746830-04           .80508046+02
                          2           .61724728-05           .66561222+02
                          3           .19928954-05           .56741729+02
                          4           .50246394-05           .64774136+02
FIELD POINT          RADIUS    .119700+04     AZIMUTH      .165970+03    ELEVATION    -.303300+02
                   HARMONIC         SOUND PRESSURE               SPL
                          1           .48787879-04           .84504022+02
                          2           .80634497-05           .68882456+02
                          3           .38760025-05           .62519719+02
                          4           .81912515-05           .69019043+02
FIELD POINT          RADIUS    .111400+04     AZIMUTH      .164480+03    ELEVATION    -.330700+02
                   HARMONIC         SOUND PRESSURE               SPL
                          1           .55254716-04           .85599425+02
                          2           .82697833-05           .69101921+02
                          3           .50112356-05           .64750934+02
                          4           .91960707-05           .70024085+02
FIELD POINT          RADIUS    .103500+04     AZIMUTH      .162250+03    ELEVATION    -.359700+02
                   HARMONIC         SOUND PRESSURE               SPL
                          1           .62364990-04           .86650855+02
                          2           .79715445-05           .68782887+02
                          3           .65207674-05           .67038012+02
                          4           .98726369-05           .70640702+02
FIELD POINT          RADIUS    .960000+03     AZIMUTH      .160350+03    ELEVATION    -.392800+02
                   HARMONIC         SOUND PRESSURE               SPL
                          1           .69750150-04           .87622940+02
                          2           .75677435-05           .68331366+02
                          3           .86041009-05           .69446149+02
                          4           .10340351-04           .71042743+02
FIELD POINT          RADIUS    .890000+03     AZIMUTH      .157330+03    ELEVATION    -.430800+02
                   HARMONIC         SOUND PRESSURE               SPL
                          1           .77289732-04           .88514473+02
                          2           .64200964-05           .66902869+02
                          3           .11214161-04           .71147373+02
                          4           .97663680-05           .70546699+02
FIELD POINT          RADIUS    .826000+03     AZIMUTH      .153430+03    ELEVATION    -.474000+02
                   HARMONIC         SOUND PRESSURE               SPL
                          1           .84002302-04           .89237861+02
                          2           .48359390-05           .64441655+02
                          3           .14103144-04           .73738356+02
                          4           .78029282-05           .68597191+02
FIELD POINT          RADIUS    .769000+03     AZIMUTH      .148010+03    ELEVATION    -.521800+02
                   HARMONIC         SOUND PRESSURE               SPL
```

Figure 3. Sample Output - Continued.

```
                         1          .88713944-04              .89711875+02
                         2          .35515691-05              .61760443+02
                         3          .16948111-04              .75334465+02
                         4          .45795711-05              .63968535+02
FIELD POINT         RADIUS    .723000+03      AZIMUTH     .140200+03    ELEVATION    -.572800+02
                  HARMONIC         SOUND PRESSURE                SPL
                         1          .89569774-04              .89795267+02
                         2          .45853212-05              .63979433+02
                         3          .19854157-04              .76709068+02
                         4          .28748377-05              .59924305+02
FIELD POINT         RADIUS    .687000+03      AZIMUTH     .128670+03    ELEVATION    -.622300+02
                  HARMONIC         SOUND PRESSURE                SPL
                         1          .85585877-04              .89400079+02
                         2          .75959000-05              .66463623+02
                         3          .22163404-04              .7[illegible]664767+02
                         4          .40051114-05              .62804330+02
FIELD POINT         RADIUS    .659000+03      AZIMUTH     .121800+03    ELEVATION    -.659000+02
                  HARMONIC         SOUND PRESSURE                SPL
                         1          .81181397-04              .88941169+02
                         2          .90659782-05              .69900331+02
                         3          .22688380-04              .77868108+02
                         4          .40829200-05              .62971456+02
FIELD POINT         RADIUS    .682000+03      AZIMUTH     .513000+02    ELEVATION    -.620000+02
                  HARMONIC         SOUND PRESSURE                SPL
                         1          .51113038-04              .84922672+02
                         2          .14506783-04              .73983460+02
                         3          .17393360-04              .75559707+02
                         4          .33396810-05              .61226138+02
FIELD POINT         RADIUS    .822000+03      AZIMUTH     .266000+02    ELEVATION    -.471000+02
                  HARMONIC         SOUND PRESSURE                SPL
                         1          .40724800-04              .82949216+02
                         2          .78601208-05              .68660622+02
                         3          .10790065-04              .71412520+02
                         4          .11445665-05              .51924859+02
FIELD POINT         RADIUS    .103100+04      AZIMUTH     .174000+02    ELEVATION    -.357000+02
                  HARMONIC         SOUND PRESSURE                SPL
                         1          .26010733-04              .79055090+02
                         2          .32408909-05              .60965327+02
                         3          .71731905-05              .67866286+02
                         4          .19797893-05              .56684418+02
```

Figure 3. Sample Output - Continued.

ROTATIONAL NOISE PROGRAM E676

HARMONIC = 1

| FIELD POINT | FIELD POINT COORDINATES (IN) X | Y | Z | SOUND PRESSURE LEVEL DECIBELS |
|---|---|---|---|---|
| 1 | -1.6800+04 | 3.0000+03 | -7.3200+03 | 8.0674+01 |
| 2 | -1.2000+04 | 3.0000+03 | -7.2960+03 | 8.4818+01 |
| 3 | -1.0800+04 | 3.0000+03 | -7.2960+03 | 8.5917+01 |
| 4 | -9.6000+03 | 3.0000+03 | -7.2960+03 | 8.7012+01 |
| 5 | -8.4000+03 | 3.0000+03 | -7.2960+03 | 8.8074+01 |
| 6 | -7.2000+03 | 3.0000+03 | -7.2960+03 | 8.9058+01 |
| 7 | -6.0000+03 | 3.0000+03 | -7.2960+03 | 8.9897+01 |
| 8 | -4.8000+03 | 3.0000+03 | -7.2960+03 | 9.0497+01 |
| 9 | -3.6000+03 | 3.0000+03 | -7.2960+03 | 9.0735+01 |
| 10 | -2.4000+03 | 3.0000+03 | -7.2960+03 | 9.0462+01 |
| 11 | -1.2000+03 | 3.0000+03 | -7.2240+03 | 8.9636+01 |
| 12 | 2.4000+03 | 3.0000+03 | -7.2240+03 | 8.3730+01 |
| 13 | 6.0000+03 | 3.0000+03 | -7.2240+03 | 7.9509+01 |
| 14 | 9.6000+03 | 3.0000+03 | -7.2240+03 | 7.5340+01 |

HARMONIC = 2

| FIELD POINT | FIELD POINT COORDINATES (IN) X | Y | Z | SOUND PRESSURE LEVEL DECIBELS |
|---|---|---|---|---|
| 1 | -1.6800+04 | 3.0000+03 | -7.3200+03 | 6.7485+01 |
| 2 | -1.2000+04 | 3.0000+03 | -7.2960+03 | 6.8965+01 |
| 3 | -1.0800+04 | 3.0000+03 | -7.2960+03 | 6.8820+01 |
| 4 | -9.6000+03 | 3.0000+03 | -7.2960+03 | 6.8491+01 |
| 5 | -8.4000+03 | 3.0000+03 | -7.2960+03 | 6.8567+01 |
| 6 | -7.2000+03 | 3.0000+03 | -7.2960+03 | 7.0262+01 |
| 7 | -6.0000+03 | 3.0000+03 | -7.2960+03 | 7.3457+01 |
| 8 | -4.8000+03 | 3.0000+03 | -7.2960+03 | 7.6751+01 |
| 9 | -3.6000+03 | 3.0000+03 | -7.2960+03 | 7.9431+01 |
| 10 | -2.4000+03 | 3.0000+03 | -7.2960+03 | 8.1343+01 |
| 11 | -1.2000+03 | 3.0000+03 | -7.2240+03 | 8.2463+01 |
| 12 | 2.4000+03 | 3.0000+03 | -7.2240+03 | 7.7527+01 |
| 13 | 6.0000+03 | 3.0000+03 | -7.2240+03 | 6.1343+01 |
| 14 | 9.6000+03 | 3.0000+03 | -7.2240+03 | 6.7794+01 |

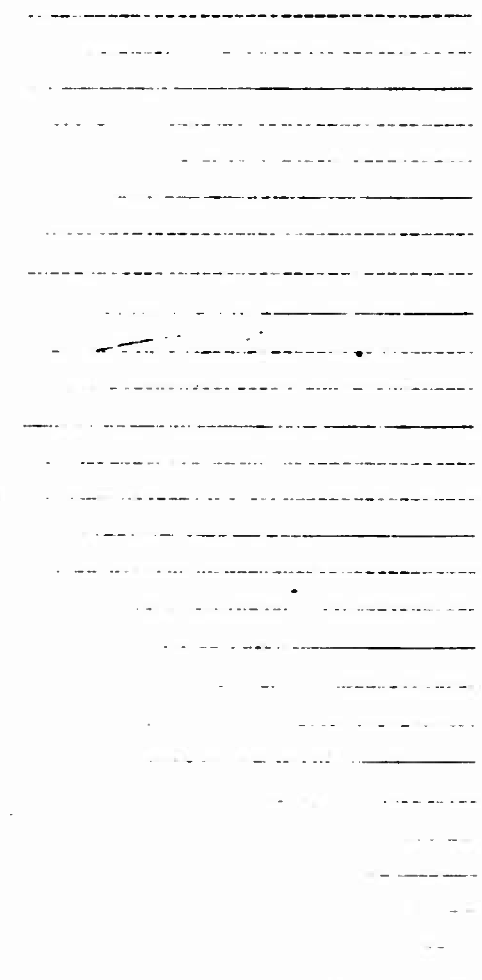


Figure 3. Sample Output - Continued.

ROTATIONAL NOISE PROGRAM E676

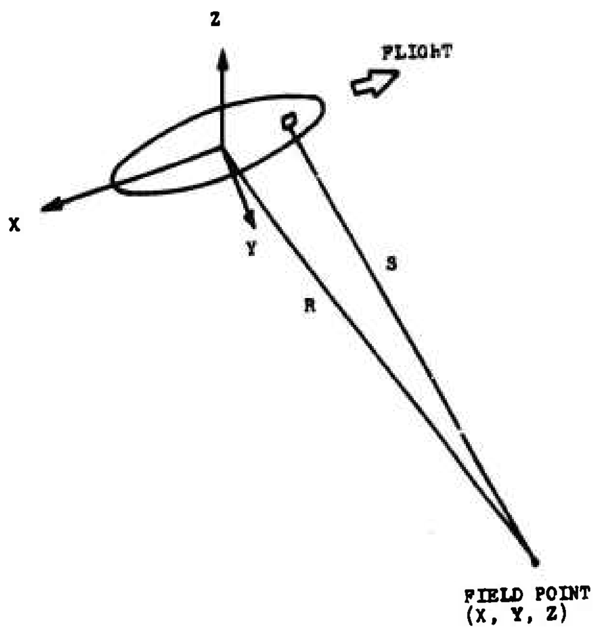
HARMONIC = 3

| FIELD POINT | FIELD POINT COORDINATES (IN) X | Y | Z | SOUND PRESSURE LEVEL DECIBELS |
|---|---|---|---|---|
| 1 | -1.6800+04 | 3.0000+03 | -7.3200+03 | 7.0054+01 |
| 2 | -1.2000+04 | 3.0000+03 | -7.2960+03 | 7.4959+01 |
| 3 | -1.0800+04 | 3.0000+03 | -7.2960+03 | 7.6184+01 |
| 4 | -9.6000+03 | 3.0000+03 | -7.2960+03 | 7.7293+01 |
| 5 | -8.4000+03 | 3.0000+03 | -7.2960+03 | 7.8147+01 |
| 6 | -7.2000+03 | 3.0000+03 | -7.2960+03 | 7.8525+01 |
| 7 | -6.0000+03 | 3.0000+03 | -7.2960+03 | 7.8139+01 |
| 8 | -4.8000+03 | 3.0000+03 | -7.2960+03 | 7.7259+01 |
| 9 | -3.6000+03 | 3.0000+03 | -7.2960+03 | 7.8703+01 |
| 10 | -2.4000+03 | 3.0000+03 | -7.2960+03 | 8.2059+01 |
| 11 | -1.2000+03 | 3.0000+03 | -7.2240+03 | 8.3364+01 |
| 12 | 2.4000+03 | 3.0000+03 | -7.2240+03 | 7.9220+01 |
| 13 | 6.0000+03 | 3.0000+03 | -7.2240+03 | 7.4849+01 |
| 14 | 9.6000+03 | 3.0000+03 | -7.2240+03 | 6.6092+01 |

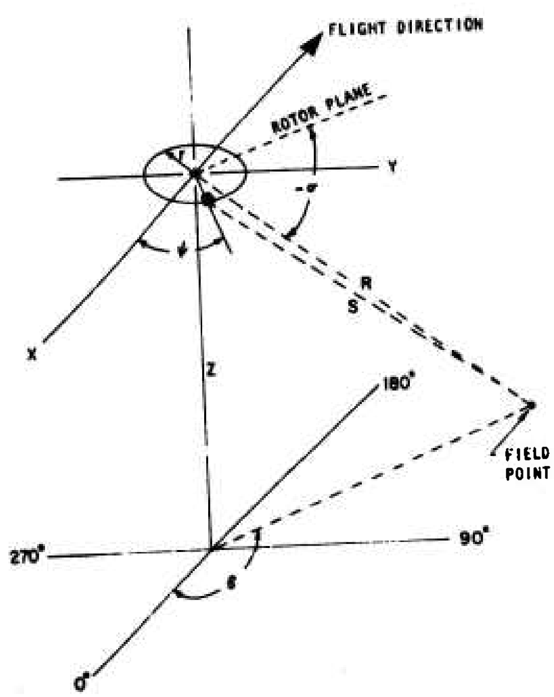
HARMONIC = 4

| FIELD POINT | FIELD POINT COORDINATES (IN) X | Y | Z | SOUND PRESSURE LEVEL DECIBELS |
|---|---|---|---|---|
| 1 | -1.6800+04 | 3.0000+03 | -7.3200+03 | 6.2514+01 |
| 2 | -1.2000+04 | 3.0000+03 | -7.2960+03 | 6.8894+01 |
| 3 | -1.0800+04 | 3.0000+03 | -7.2960+03 | 7.1086+01 |
| 4 | -9.6000+03 | 3.0000+03 | -7.2960+03 | 7.3444+01 |
| 5 | -8.4000+03 | 3.0000+03 | -7.2960+03 | 7.5815+01 |
| 6 | -7.2000+03 | 3.0000+03 | -7.2960+03 | 7.7899+01 |
| 7 | -6.0000+03 | 3.0000+03 | -7.2960+03 | 7.9145+01 |
| 8 | -4.8000+03 | 3.0000+03 | -7.2960+03 | 7.8402+01 |
| 9 | -3.6000+03 | 3.0000+03 | -7.2960+03 | 7.1984+01 |
| 10 | -2.4000+03 | 3.0000+03 | -7.2960+03 | 7.0577+01 |
| 11 | -1.2000+03 | 3.0000+03 | -7.2240+03 | 7.8219+01 |
| 12 | 2.4000+03 | 3.0000+03 | -7.2240+03 | 7.3212+01 |
| 13 | 6.0000+03 | 3.0000+03 | -7.2240+03 | 7.0343+01 |
| 14 | 9.6000+03 | 3.0000+03 | -7.2240+03 | 5.1346+01 |

Figure 3. Sample Output - Concluded.




a. OPRONO Coordinates.




b. E3860P Coordinates.

Figure 4. Coordinate Systems for Noise Prediction.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0   CD COUNT

C ROTOR NOISE PROGRAM FOR W. BAUSCH BY G. CAMPE.
      COMMON /BK1/ IDD,BB,AA,XA(5,5),DPSI,RR(5),OMEG,CC,NBLADE,MLIMRN,
     * MLIMOP,XFP(20),YFP(20),ZFP(20),GAMA,RO,BLADEL,BO,B1C,B1S,PUNCH,
     * LSPAN,FROC(30),TCOP,SLOPE(10,5),OFFSET(10,5),KUNIT(5),IBURST,
     * IRS(5),ITRACK(5),FI(5,5),NCHAN(5,5),E3860P,NFT,ANG,KEY1,KEY2,
     * KEY3,NHH,CAPRF(20),THETAF(20),ALFAF(20),OPRUNO,NCH(5),INTERM,
     * IREEL,NC,NTBOX(5,10),NSTATC(5,10),NSTATR(5,10),ISET(5),IREELS,
     * NOCH(5),LAZI
      COMMON /BK2/ NCYCLE,CYCLES,KU,NDIV(4),BMASK(6),NN(435),LIRS,
     * KTRACK,KBURST,KREC,ND1(144,10,5),ND2(144,10,5),XLO(7),XLM(7,40),
     * XMM(7,40),TEMP1(7),TEMP2(7),TEMP3(7),PI,AZMTH2(144),AZMTH(144),
     * UPRAD,AZRAD,NO,YES,NBLANK,TEE,BEE,DEE,GMARI(288,20),
     * HMARI(288,20),XO(20)
      COMMON /BK3/ SPLM(10,20),AZMTH3(288),
     * SPAN(20),                         PMRMS(10,20),
     * ICHANL(10,5),COSINE(288),SINE(288),BLADES,CARD,TAPE
      COMMON /TEMPUS/ TIME,COUNT
      DIMENSION DATA1(144,10,5),DATA2(144,10,5),FN(144),CHORD(7),
     * GPSI(7),GPSI1(7),TEM1(30),TEM2(30),CHORD2(41),GPSI2(41),GPSI3(41)
     *,COSRN(41),SINRN(41)
      EQUIVALENCE (ND1,DATA1),(ND2,DATA2),(NN,FN),(TEMP1,CHORD),
     * (TEMP2,GPSI),(TEMP3,GPSI1)
      DIMENSION CN(31,5,5),SN(30,5,5),AN(31,10,5),BN(30,10,5),
     * GMAR(144,5),HMAR(144,5)
     * ,Q1(288,20),Q2(288,20)
      EQUIVALENCE                  (ND2(5671),HMAR),(GMARI,AN),
     * (GMARI(1551),BN),(HMARI,CN),(HMARI(776),SN),(ND2,Q2)
      EQUIVALENCE (ND1(5761),GMAR),(ND1,Q1)
      DIMENSION AZ41(41)
      DIMENSION DBI(289)
      EQUIVALENCE (DBI,SINE)
      MSTART=1
      CALL INPUTA
      IF(TCOP.EQ.CARD) GO TO 199
      REWIND 8
      REWIND 9
      REWIND 10
      REWIND 11
      REWIND 12
      REWIND 13
  199 LIRS = 0
      PI = 3.14159265
      DO 1 I=1,5
      IF(IRS(I).NE.0) LIRS = LIRS+1
    1 CONTINUE
      UPRAD = DPSI*6.28318531/360.
      AZRAD = (2.5*PI)/180.
      AZMTH(1) = 0.
      AZMTH2(1) = 0.
      DO 2 I=2,144
      AZMTH2(I) = AZMTH2(I-1)+AZRAD
    2 AZMTH(I)  = AZMTH(I-1)+2.5
      PI2 = 6.283185
      AZMTH3(1)=0.
```

Figure 5. Program Listing - Main.

```
1       1         2         3         4         5         6         7         8
........0.........0.........0.........0.........0.........0.........0.........0
      COSINE(1)=1.
      SINE(1)=0.
      T1=(PI2/DPRAD)+.001
      J=T1
      IF(J.LE.288) GO TO 211
      WRITE(6,212)
  212 FORMAT(1H1, 63HTHE DIMENSION OF AZMTH3 HAS BEEN EXCEEDED AT
     *ENT NO. 211     )
      WRITE(6,35) (AZMTH3(L),L=1,288)
      WRITE(6,35) PI2
      STOP
  211 DO 4 LAZI=2,J
      AZMTH3(LAZI) = AZMTH3(LAZI-1)+DPRAD
      COSINE(LAZI) = COS(AZMTH3(LAZI))
    4 SINE(LAZI)   = SIN(AZMTH3(LAZI))
      IF(IDD.NE.1) GO TO 210
      WRITE(6,213)
  213 FORMAT(1H1,11HAZMTH3(288))
      WRITE(6,35) (AZMTH3(L),L=1,288)
  210 BLADES = NBLADE
      T1 = 1./41.
      CHORD2(1) = 0.
      CHORD2(41) = 1.
      DO 6 L=2,40
    6 CHORD2(L) = CHORD2(L-1)+T1
C
C *** A LONG LOOP ON BURSTS IS NEXT.
    7 IF(IDD.NE.1) GO TO 9300
      CALL START
 9300 IF(TCOP.EQ.CARD) GO TO 10
      READ(5,8) IBURST
C GET START OF BURST TIME
    8 FORMAT( 11X,I3 )
C
C *** A CHOISE I MADE NEXT (OPTION) TO EITHER  ACEPT TAPE OR CARD INPUT.
      DO 9 I=1,144
      DO 9 J=1,10
      DO 9 K=1,5
    9 ND2(I,J,K) = 0
C
C *** LOOP ON TAPE REELS FOLLOWS.
      DO 11 IREEL=1,IREELS
      KU = KUNIT(IREEL)
      IF(IDD.EQ.1)
     XWRITE(6,231) IREEL,KU
   12 CALL RDKU(1)
      IF(IBURST.NE.KBURST) GO TO 12
      IF(IDD.EQ.1)
     XWRITE(6,231) IREEL,KU,KREC,KBURST,KTRACK
      GO TO (13,13,13,13,13,13,13,13,14,15,16,17),KU
   13 BACKSPACE 8
      GO TO 18
   14 BACKSPACE 9
      GO TO 18
```

Figure6 . Program Listing - Main.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0

   15 BACKSPACE 10
      GO TO 18
   16 BACKSPACE 11
      GO TO 18
   17 BACKSPACE 12
      BACKSPACE 13
   18 NCYCLE = 0
C *** THE FIRST CYCLE IN BURST IBURST IS READ.
      CALL RDKU(1)
      CALL RDKU(2)
      KB = KBURST
      GO TO 19
C *** THE REMAINING CYCLES IN BURST IBURST ARE READ AND AVERAGED.
   20 CALL RDKU(1)
      IF(KBURST.NE.KB) GO TO 21
      CALL RDKU(2)
      IF(KBURST.NE.KB) GO TO 21
C
C *** SUBR. UNPACK UNPACKS NN(435) TO FORM ND1(I,J,K) WHERE I=DATA POINT,
C *** J=CHANNEL, K=REEL NO.
   19 CALL UNPACK
      NCYCLE = NCYCLE+1
C *** CHANNEL LOOP
      K = NOCH(IREEL)
      DO 22 J=1,K
      NC = ICHANL(J,IREEL)
      IF(IDD-1) 234,236,234
  236 IF(IREEL-1) 234,235,234
  235 IF(IDD.EQ.1)                 WRITE(6,231) NCYCLE,K,NC,ND1(1,NC,IREE
     X L)
  234 CONTINUE
  231 FORMAT(4I13)
      DO 22 I=1,144
      ND2(I,NC,IREEL) = ND2(I,NC,IREEL) + ND1(I,NC,IREEL)
   22 CONTINUE
      GO TO 20
C *** AT THIS POINT THE END OF BURST HAS BEEN REACHED.
   21 GO TO (23,23,23,23,23,23,23,23,24,25,26,27),KU
   23 BACKSPACE 8
      GO TO 28
   24 BACKSPACE 9
      GO TO 28
   25 BACKSPACE 10
      GO TO 28
   26 BACKSPACE 11
      GO TO 28
   27 BACKSPACE 12
      BACKSPACE 13
   28 CYCLES = NCYCLE
C *** THE AVERAGE CYCLES ARE FOUND NEXT.
      K = NOCH(IREEL)
      DO 29 J=1,K
      NC = ICHANL(J,IREEL)
      DO 29 I=1,144
```

Figure 7. Program Listing - Main.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0
      T1 = NO2(I,NC,IREEL)
   29 DATA2(I,NC,IREEL) = T1/CYCLES
   11 CONTINUE
C *** FILTER ROLL OFF CORRECTION AND TAPE DATA SCALING FOLLOWS.
      DO 30 IREEL=1,IREELS
      K = NOCH(IREEL)
      DO 30 J=1,K
      NC = ICHANL(J,IREEL)
      DO 31 I=1,144
   31 FN(I) = DATA2(I,NC,IREEL)
      CALL DFSRIE (144,MLIMDP,FN,TEM1,TEM2)
      AN(1,NC,IREEL) = TEM1(1)
      DO 32 I=1,MLIMDP
      AN(I+1,NC,IREEL) = TEM1(I+1)                                    9999
   32 BN(I,NC,IREEL) = TEM2(I+1)
      IF(IDD.NE.1) GO TO 30
      WRITE(6,33) IREEL,NC,(FN(L),L=1,144)
   33 FORMAT(1H0, 5HREEL=,I3, 7X, 8HCHANNEL=, I3, 7X, 35HAVE. CYCLE AND
     1ITS HARMONICS FOLLOW // (2X,1PE10.3,12E10.3) )
      I=MLIMDP+1
      WRITE(6,34) (AN(L,NC,IREEL),L=1,I)
      WRITE(6,35) (BN(L,NC,IREEL),L=1,MLIMDP)
   34 FORMAT(1H0,1X,1PE10.3 / (2X,13E10.3))
   35 FORMAT( /  (2X,1PE10.3,12E10.3))
   30 CONTINUE
      DO 36 IREEL=1,IREELS
      IF(IDD.EQ.1) WRITE(6,40) IREEL
   40 FORMAT(1H0,10HREEL NO. =,I3,10X, 77HAVE. PRESSURE CYCLE HARMONICS
     X(CORRECTED FOR FILTER ROLL-OFF AND ENGR. UNITS)  )
      K=NOCH(IREEL)
      DO 36 J=1,K
      NC = ICHANL(J,IREEL)
      AN(1,NC,IREEL) = AN(1,NC,IREEL)*SLOPE(NC,IREEL)+OFFSET(NC,IREEL)
      DO 37 I=1,MLIMDP
      T1 = FROC(I)*SLOPE(NC,IREEL)
      AN(I+1,NC,IREEL) = AN(I+1,NC,IREEL)*T1
   37 BN(I,NC,IREEL) = BN(I,NC,IREEL)*T1
      IF(IDD.NE.1) GO TO 36
      WRITE(6,38)  NC,AN(1,NC,IREEL),(AN(I+1,NC,IREEL),I=1,MLIMDP)
   38 FORMAT(1X,  8HCHANNEL=,I3,5X, 11(1PE10.3) /  (27X,10E10.3 / ) )
      WRITE(6,39) (BN(I,NC,IREEL),I=1,MLIMDP)
   39 FORMAT( 27X,10(1PE10.3) / (27X,10E10.3) )
   36 CONTINUE
C *** THE FOLLOWING SUBR. COMBINES THE TOP AND BOTTOM ABSOLUTE PRESSURE COEFF.
C     TO PRODUCE DIFFERENTIAL PRESS. COEFF.  CN(31,5,5), SN(30,5,5) WHERE THE
C     FIRST SUBS. = HARMONIC, SECOND SUBS. = CHORD, THIRD SUBS. = SPAN.
C     BLADE PITCH HARMONICS, B0,B1C,B1S  ARE ALSO CALCULATED.
      CALL MERGES
      IF(IDD.NE.1) GO TO 240
      DO 239 I=1,5
      DO 239 J=1,5
      WRITE(6,47) CN(1,J,I)
      WRITE(6,47) (CN(K+1,J,I),K=1,MLIMDP)
  239 WRITE(6,47) (SN(K,J,I),K=1,MLIMDP)
```

Figure 8. Program Listing - Main.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0

C *** NOW THE DIFFERENTIAL PRESSURE FOURIER COEFFICIENTS OF THE AVERAGE CYCLES
C     IS PUNCHED OUT.
      IF(PUNCH.NE.YES) GO TO 41
  240 WRITE(7,42) IBURST
   42 FORMAT( 11HBURST NO. =,I3,11X, 34H*** ROTOR NOISE PUNCHED OUTPUT *
     X**)
      WRITE(7,43) B0,B1C,B1S
   43 FORMAT( 21HBLADE PITCH HARMONICS /  3(1PE10.4),2X, 46H(COLLECTIVE,
     XLONGITUDINAL,LATERAL RESPECTIVELY) /  75HDIFFERENTIAL PRESSURE HAR
     XMONICS FOR 5 CHORD STATIONS AT EACH OF THE 5 SPANS / 66H(MEASURING
     X FROM THE LEADING EDGE AND THE BLADE ROOT RESPECTIVELY).  )
C *** SPAN LOOP
      DO 44 I=1,5
C *** CHORD LOOP
      DO 44 J=1,5
      WRITE(7,49) I,J,CN(1,J,I)
   49 FORMAT( 4HSPAN,I2,2X, 5HCHORD,I2,7X, 8HSTEADY= , 1PE10.4 )
      WRITE(7,45)
   45 FORMAT( 19HCOSINE COEFFICIENTS )
   47 FORMAT(  8(1PE10.4) )
      WRITE(7,47) (CN(K+1,J,I),K=1,MLIMDP)
      WRITE(7,48)
   48 FORMAT( 17HSINE COEFFICIENTS )
   44 WRITE(7,47) (SN(K,J,I),K=1,MLIMDP)
      GO TO 41
C *** CARD INPUT (INSTEAD OF TAPE INPUT) IS ACCEPTED NEXT.
   10 READ(5,42) IBURST
      READ(5,43) B0,B1C,B1S
C *** SPAN LOOP
      DO 50 I=1,5
C *** CHORD LOOP
      DO 50 J=1,5
      READ(5,49) IN,JN,CN(1,JN,IN)
      READ(5,45)
      READ(5,47) (CN(K+1,J,I),K=1,MLIMDP)
      READ(5,48)
   50 READ(5,47) (SN(K,J,I),K=1,MLIMDP)
C *** AVERAGE DIFFERENTIAL PRESSURE CYCLES FOR SPAN I CHORD J AZIMUTH K ARE
C     FOUND BY SUMMING THE CORRECTED HARMONICS.
C *** SPAN LOOP
C AT THIS POINT THE PRESSURE INPUT HAS BEEN ACCEPTED (TAPE OR CARD INPUT)
   41 IF(IDD.NE.1) GO TO 9301
      CALL CLOCK
 9301 DO 51 I=1,5
C *** CHORD LOOP
      DO 51 J=1,5
      T1 = -AZRAD
C *** AZIMUTH (POINT) LOOP
      DO 51 K=1,144
      DATA1(K,J,I) = CN(1,J,I)
      T1 = T1+AZRAD
      T3 = 0.
C *** HARMONIC LOOP
      DO 51 L=1,MLIMDP
```

Figure 9. Program Listing - Main.

```
1         1         2         3         4         5         6         7         8
........0.........0.........0.........0.........0.........0.........0.........0
      T3 = T3+1.
      T2 = T1*T3
   51 DATA1(K,J,I) = DATA1(K,J,I)+CN(L+1,J,I)*COS(T2)+SN(L,J,I)*SIN(T2)
      WRITE(6,54)
   54 FORMAT(1H1,59HDIFFERENTIAL PRESSURE CYCLES AT INSTRUMENTED BLADE S
     XTATIONS // )
      DO 53 I=1,5
      DO 53 J=1,5
      WRITE(6,55) I,J
   55 FORMAT(1H0, 12HSPAN STATION,I3,5X,13HCHORD STATION, I3//)
   53 WRITE(6,56) (DATA1(K,J,I),K=1,144)
   56 FORMAT( 2X,10(1PE13.4) )
C *** THE FOLLOWING INPUT OPTION DESIDES WHETHER OR NOT TO CALL THE ACOUSTICS
C     PROGRAM E386 WHICH IS A SIMPLIFIED VERSION OF THIS PROGRAM.
   52 IF(E386OP.NE.YES) GO TO 57
      KK = 1
      XLO(1) = 0.
      DO 9501 J=1,NHH
      XLM(1,KK) = 0.
 9501 XMM(1,KK) = 0.
C *** RADIAL STATION LOOP
      DO 58 I=1,5
      KK = KK+1
      IF(IRS(I).EQ.0) GO TO 58
      IF(NCH(I).EQ.5) GO TO 59
      NT1 = NCH(I)+2
      K=1
      CHORD(1) = 0.
      DO 60 L=1,5
      IF(NCHAN(I,L).EQ.0) GO TO 60
      K=K+1
      CHORD(K)=XA(L,I)
   60 CONTINUE
      CHORD(K+1)=1.
      GPSI(1)=0.
      DO 61 J=1,144
      K=1
      DO 62 L=1,5
      IF(NCHAN(I,L).EQ.0) GO TO 62
      K=K+1
      GPSI(K) = DATA1(J,L,I)
   62 CONTINUE
      GPSI(K+1) = 0.
      CALL AVQUAD(NT1,CHORD,GPSI,AREA)
   61 FN(J) = AREA*AA
      GO TO 63
   59 DO 64 J=1,144
      FN(J) = 0.
      DO 65 L=1,5
   65 FN(J) = FN(J)+DATA1(J,L,I)*FI(I,L)
   64 FN(J) = FN(J)*AA
   63 CALL DFSRIE(144,NHH,FN,TEM1,TEM2)
      XLO(KK) = TEM1(1)
      DO 66 J=1,NHH
```

Figure 10. Program Listing - Main.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0    CD COUNT

      XLM(KK,J) = TEM1(J+1)
   66 XMM(KK,J) = TEM2(J+1)
   58 CONTINUE
      KK = KK+1
      XLO(KK) = 0.
      DO 9500 J=1,NHH
      XLM(KK,J) = 0.
 9500 XMM(KK,J) = 0.
      WRITE(6,201)
  201 FORMAT(1H1, 11HXLO XLM XMM ,///)
      DO 202 KK=1,7
      WRITE(6,203) XLO(KK),(XLM(KK,J),J=1,NHH),(XMM(KK,J),J=1,NHH)
  220 FORMAT(//(1PE13.5))
  203 FORMAT(F8.2/(10F8.2))
  202 CONTINUE
  200 CALL E386RN
   57 IF(OPHONO.NE.YES) GO TO 7
C BEGINNING OF ROTOR NOISE ANALYSIS
      IF(IDD.NE.1) GO TO 9302
      CALL START
 9302 I1 = LSPAN-1
      T1 = 298./T1
      DELSPN = T1/2.
      SPAN(1) = 74.
      DO 67 L=2,LSPAN
   67 SPAN(L) = SPAN(L-1)+T1
      L=MSTART-1
      FM=L
      T4 = BLADES/(PI*BB)
      DIMENSION RSQ(18)
      REWIND 28
      IF(IDD.NE.1) GO TO 9103
      GC2=SPAN(1)+DELSPN
      J=LSPAN-2
      DO 10005 I=1,J
      GC1=GC2+T1
      RSQ(I)= PI*(GC1**2-GC2**2)/(288.*SPAN(I+1))
10005 GC2=GC1
      WRITE(6,8826) (RSQ(I),I=1,18)
      GO TO 9103
 9100 WRITE(6,9104) LSD2
 9104 FORMAT(1HQ,11HNTRAN ERROR , 5I13)
      STOP
 9103 WRITE(28) (ND1(I),I=1,7200)
      WRITE(28) (SINE(I),I=1,288),BLADES
      END FILE 28
      LSD2= 1
C *** HARMONIC LOOP
      DO 83 M=MSTART,MLIMRN
      REWIND 28
      READ (28) (ND1(I),I=1,7200)
      FM = FM+1.
C *** RADIAL STATION LOOP
      CALL NTRAN(29,10)
```

Figure 11. Program Listing - Main, Noise Analysis Begins.

```
1       1         2         3         4         5         6         7         8
........0.........0.........0.........0.........0.........0.........0.........0

      DO 69 K=1,5
      IF(IRS(K).EQ.0) GO TO 69
      T5=AA/(2.*RR(K)*BLADEL)
C *** AZIMUTHAL LOOP
      DO 99 I=1,144
      T1=-T5
      T2= T5
      T3 =  (T2-T1)/40.
      T6=T1*BLADES*FM
      COSRN(1) = COS(T6)
      SINRN(1) = SIN(T6)
      T6=T2*BLADES*FM
      COSRN(41) = COS(T6)
      SINRN(41) = SIN(T6)
      AZ41(1)=T1
      AZ41(41)=T2
      L=0
      DO 71 J=2,40
      T1=T1+T3
      T6=T1*BLADES*FM
      AZ41(J)=T1
      COSRN(J) = COS(T6)
      SINRN(J) = SIN(T6)
   71 CONTINUE
      NT1 = NCH(K)+2
      KKK = 1
      CHORD(1)=0.
      GPSI(1)=0.
      DO 72 L=1,5
      IF(NCHAN(K,L).EQ.0) GO TO 72
      KKK = KKK + 1
      CHORD(KKK) = XA(L,K)
      GPSI(KKK) = DATA1(I,L,K)
   72 CONTINUE
      CHORD(KKK+1) = 1.
      GPSI(KKK+1) = 0.
C *** THE MEASURED PRESSURE POINTS ALONG THE CHORD ARE INTERPOLATED TO 41 POINTS
      CHORD2(1)=0.
      CHORD2(41) = 1.
      AREA = 1./41.
      DO 9307 L=2,40
 9307 CHORD2(L) = CHORD2(L-1) + AREA
      CALL CURVIT(NT1,CHORD,GPSI,W,41,CHORD2,GPSI2)
      DO 73 L=1,41
   73 GPSI3(L) = GPSI2(L)*COSRN(L)
      CALL AVQUAD(41,AZ41  ,GPSI3,AREA)
      AREA = AREA*T4
 9105 IF(LSD2+1) 9106,9105,9106
 9106 CALL NTRAN(29,1,1,AREA,LSD2)
      IF(IDD.NE.1) GO TO 2741
      IF(I.GT.10) GO TO 2741
      IF(K.GT.2) GO TO 2741
      WRITE(6,2742) I,K,M,NT1
 2742 FORMAT(1H0,2HI=,I5,5X,2HK=,I5,5X,2HM=,I5,10X,
```

Figure 12. Program Listing - Main.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0

     X  33 HACOUSTIC PRESSURE PULSE COS TERM     ,10X,I5)
      WRITE(6,2747)  COSRN
      WRITE(6,2747)  CHORD
      WRITE(6,2747)  GPSI
      WRITE(6,2747)  CHORD2
      WRITE(6,2747)  GPSI2
      WRITE(6,2747)  T1,T2,T3,T4,T5,GMAR(I,K),AREA,FM
 2747 FORMAT(2X,1P10E13.5)
 2741 DO 74 L=1,41
   74 GPSI3(L) = GPSI2(L)*SINRN(L)
      CALL AVQUAD(41,AZ41  ,GPSI3,AREA)
      AREA = AREA*T4
 9107 IF(LSD2+1)9100,9107,9108
 9108 CALL NTRAN(29,1,1,AREA,LSD2)
   99 CONTINUE
   69 CONTINUE
 9200 IF(LSD2+1) 9100,9200,9201
 9201 CALL NTRAN(29,10)
      DO 9109 K=1,5
      DO 9109 I=1,144
 9110 IF(LSD2+1) 9100,9110,9111
 9111 CALL NTRAN(29,2,1,AREA,LSD2)
 9112 IF(LSD2+1) 9100,9112,9113
 9113 GMAR(I,K)=AREA
      CALL NTRAN(29,2,1,AREA,LSD2)
 9114 IF(LSD2+1) 9100,9114,9115
 9115 HMAR(I,K) = AREA
 9109 CONTINUE
      IF(IDD.NE.1) GO TO 75
      WRITE(6,76) M
   76 FORMAT(1H0,123HCOS AND SIN COEFFICIENTS OF ACOUSTIC PRESSURE PULSE
     X AT EACH OF 144 AZIMUTHAL STATIONS AT EACH BLADE STATION FOR HARMO
     XNIC M=,I3 )
      DO 77 I=1,5
      WRITE(6,78) I
   78 FORMAT(1H0,14HBLADE STATION=,I2)
      WRITE(6,56) (GMAR(K,I),K=1,144)
   77 WRITE(6,56) (HMAR(K,I),K=1,144)
C *** THE FOLLOWING SUBR. INTERPOLATES ACOUSTIC PRESSURE PULSE HARMONICS UP TO
C     288 AZIMUTH AND 20 BLADE STATIONS
   75 IF(IDD.NE.1) GO TO 9303
      CALL CLOCK
 9303 CALL INTERP
      IF(IDD.NE.1) GO TO 79
      CALL CLOCK
      WRITE(6,80) LAZI,LSPAN
   80 FORMAT(1H1, 51HINTERPOLATED ACOUSTIC PRESSURE PULSE COEFFICIENTS (
     X ,I3,1X,17HAZIMUTH STATIONS, ,I3,1X,17HBLADE STATIONS  )  ///)
      DO 81 I=1,LSPAN
      WRITE(6,82) SPAN(I)
   82 FORMAT(1H0,11HBLADE SPAN=, F8.2,10X,21HGMARI(J,I),HMARI(J,I)  )
      WRITE(6,56)  (GMARI(J,I),J=1,LAZI)
   81 WRITE(6,56)  (HMARI(J,I),J=1,LAZI)
C *** DOUBLE INTEGRATION FOLLOWS
```

Figure 13. Program Listing - Main.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0   CD COUNT

   79 ISI = (DPSI/2.5)+.01
      T1 = BB/(4.*PI)
C *** FIELD POINT LOOP
      DO 83 NFIELD=1,NFT
      MFIELD = NFIELD
      IF(INTERM.EQ.NO)GO TO 84
      WRITE(6,85) NFIELD,XFP(NFIELD),YFP(NFIELD),ZFP(NFIELD),M
   85 FORMAT(1H1, 12HFIELD POINT=,I3,5X, 4HXFP=,1PE10.4,5X,4HYFP=,1PE10.
     X 4,5X, 4HZFP=,1PE10.4,15X, 11HHARMONIC M=,I3 )
C *** SUBR. CUE WILL CALCULATE Q1 AND Q2=Q1*Q2       Q1(288,20),Q2(288,20)
   84 READ(28) (SINE(I),I=1,288),BLADES
      BACKSPACE 28
      CALL CUE(2,FM,MFIELD)
      IF(INTERM.EQ.NO)GO TO 86
      WRITE(6,87) LAZI,LSPAN
   87 FORMAT(1H0, 3HQ1(,I3,1H,,I2,1H))
      DO 88 I=1,LSPAN
      WRITE(6,89) I,XO(I)
   89 FORMAT(1H0, 13HSPAN STATION=,I3, 1H(, F6.3,1H) )
   88 WRITE(6,90) (Q1(J,I),J=1,LAZI)
   90 FORMAT( 2X,13(1PE10.3))
C *** THE FOLLOWING LOOP EFFECTS A DOUBLE INTEGRATION WHICH YIELDS THE SOUND
C     PRESSURE COMPONENTS UMF(M,NFIELD) AND VMF(M,NFIELD).
   86 DO 91 K=1,2
      IF(INTERM.EQ.NO) GO TO 92
      I=K+1
      WRITE(6,93) I,LAZI,LSPAN
   93 FORMAT(1H0, 1HQ,I1,1H(,I3,1H,,I2,1H))
      DO 94 I=1,LSPAN
      WRITE(6,89) I,XO(I)
   94 WRITE(6,90) (Q2(J,I),J=1,LAZI)
C *** A DOUBLE INTEGRATION IS DONE NEXT.
   92 IF(IDD.NE.1) GO TO 9304
      CALL CLOCK
C RING ITEGRATION
      IAUDRE=LSPAN-2
      AREA=0.
      DO 10006 J=1,IAUDRE
      QAVR = 0.
      DO 10007 I=1,LAZI
10007 QAVR=QAVR+Q2(I,J+1)
      QAVR=QAVR*RSQ(J)
      WRITE(6,10008) J,QAVR
10008 FORMAT(  5H RING,I3,20X,E13.5)
10006 AREA=AREA+QAVR
      IF(K.EQ.2) GO TO 10009
      URING=AREA*T1
      GO TO 10010
10009 VRING=AREA*T1
10010 CONTINUE
 9304 IAUDRE = LSPAN-1
      DO 8820 I=1,LAZI
      DBI(1)=0.
      DO 8821 J=2,IAUDRE
```

Figure 14. Program Listing - Main.

```
1        1         2         3         4         5         6         7         8
........0.........0.........0.........0.........0.........0.........0.........0     CD COUNT

 8821 DBI(I)=DBI(I)+Q2(I,J)
 8820 DBI(I)= (DBI(I)*2.+Q2(I,1)+Q2(I,LSPAN))*DELSPN
      DBI(LAZI+1) = DBI(1)
      IF(IDD.NE.1) GO TO 8825
      WRITE(6,8826) (DBI(I),I=1,145),DELSPN
 8826 FORMAT(1H0,1X,10E13.5)
      CALL SIMCOR(LAZI+1,DPRAD,DBI,QAVR,1)
      TEMP1(K)=QAVR
 8825 QAVR = 0.
      DO 9701 I=1,LAZI
 9701 QAVR=QAVR+DBI(I)
      QAVR=QAVR*DPRAD*T1
      IF(K.EQ.2) GO TO 9703
      UTRAP=QAVR
      GO TO 9702
 9703 VTRAP=QAVR
C SIMPSON S
 9702 IF(IDD.NE.1) GO TO 9305
      QAVR=2.*DELSPN
      DO 10000 I=1,LAZI
      DO 10001 J=1,IAUDRE
10001 AZ41(J)=Q2(I,J+1)
      CALL SIMCOR(IAUDRE,QAVR,AZ41,AREA,J)
10000 DBI(I)=AREA
      DBI(LAZI+1) = DBI(1)
      WRITE(6,8826) (DBI(I),I=1,145),QAVR
      CALL SIMCOR(LAZI+1,DPRAD,DBI,QAVR,I)
      IF(K.EQ.2) GO TO 10002
      USIMP=QAVR*T1
      GO TO 10003
10002 VSIMP=QAVR*T1
10003 WRITE(6,2222) TEMP1(K),RO,BLADEL,T1,B8
 2222 FORMAT(1H0,5E20.6)
      CALL CLOCK
      QAVR=0.
      DO 901 IROMA=1,20
      DO 901 IAUDRE=1, 44
  901 QAVR=QAVR+Q2(IAUDRE,IROMA)
      QAVR=QAVR/2880.
      WRITE(6,902) QAVR
  902 FORMAT (1H0,11HQ AVERAGE=     ,1PE20.5)
 9305 IF(K.EQ.2) GO TO 91
C *** SUBR. CUE WILL CALCULATE Q2=Q1*Q2
      READ(28) (SINE(I),I=1,288),BLADES
      BACKSPACE 28
      CALL CUE(3,FM,MFIELD)
   91 CONTINUE
      READ(28) (SINE(I),I=1,288),BLADES
      BACKSPACE 28
      TEMP1(1)        = TEMP1(1)*T1
      TEMP1(2)        = TEMP1(2)*T1
      IF(IDD.NE.1) GO TO 95
      WRITE(6,9704)
 9704 FORMAT(1H0,85 HTHE FOLLOWING ANSWERS ARE OBTAINED BY USING TRAPAZO
```

Figure 15. Program Listing - Main.

```
1         1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0   CD COUNT
         XIDAL INTERGRATION ALONG THE BLADE, /
         X 44HAND SIMPSON S INTEGRATION ALONG THE AZIMUTH.                    )
          WRITE(6,96) M,NFIELD,TEMP1(1)      ,M,NFIELD,TEMP1(2)
      96 FORMAT(1H0,   4HUMF(,I2,1H,,I2,3H) =,1PE10.4,13X,
         X             4HVMF(,I2,1H,,I2,3H) =,1PE10.4 )
C *** SOUND PRESSURE AND SOUND PRESSURE LEVEL ARE CALCULATED NEXT
      95 PMRMS(M,NFIELD) = (1./1.41421356)*SQRT(UTRAP**2+VTRAP**2)
          SPLM(M,NFIELD) = 20.*ALOG10(PMRMS(M,NFIELD)/2.9E-09)
          IF(INTERM.EQ.NO) GO TO 31000
          WRITE(6,97) M,NFIELD,PMRMS(M,NFIELD),M,NFIELD,SPLM(M,NFIELD)
      97 FORMAT(1H0,   6HPMRMS(,I2,1H,,I2,3H) =,1PE10.4,10X,
         X             6H SPLM(,I2,1H,,I2,3H) =,1PE10.4 )
31000 IF(IDD.NE.1) GO TO 83
          WRITE(6,9705)
 9705 FORMAT(1H0,95 HTHE FOLLOWING ANSWERS ARE OBTAINED BY USING TRAPAZO
         XIDAL INTEGRATION ALONG THE BLADE AND AZIMUTH      )
          WRITE(6,96) M,NFIELD,UTRAP,M,NFIELD,VTRAP
          UTRAP=(1./1.41421356)*SQRT(UTRAP**2+VTRAP**2)
          VTRAP=20.*ALOG10(UTRAP/2.9E-09)
          WRITE(6,97) M,NFIELD,UTRAP,M,NFIELD,VTRAP
          WRITE(6,10004)
10004 FORMAT(1H0, 17H SIMPSON, SIMPSON     )
          WRITE(6,96) M,NFIELD,USIMP,M,NFIELD,VSIMP
          USIMP= (1./1.41421356)*SQRT(USIMP**2+VSIMP**2)
          VSIMP=20.*ALOG10(USIMP/2.9E-09)
          WRITE(6,97) M,NFIELD,USIMP,M,NFIELD,VSIMP
          WRITE(6,10011)
10011 FORMAT(1H0,    6H RINGS    )
          WRITE(6,96) M,NFIELD,URING,M,NFIELD,VRING
          URING=(1./1.41421356)*SQRT(URING**2+VRING**2)
          VRING=20.*ALOG10(URING/2.9E-09)
          WRITE(6,97) M,NFIELD,URING,M,NFIELD,VRING
      83 CONTINUE
C *** THE FOLLOWING SUBR. PRINTS OUT SOUND PRESSURE LEVELS FOR ALL CALCULATED
C         HARMONICS.
          CALL OUTSPL
          IF(IDD.NE.1) GO TO 7
          CALL CLOCK
          GO TO 7
          STOP
          END
QIXG      FOR CURVIT,CURVIT
          SUBROUTINE CURVIT (MM, X9, Y9, W, N, X0, Y0)
C
C
C            SIONED IN THE CALLING PROGRAM.
C            PRESENTLY W IS NOT USED IN THIS ROUTINE, HOWEVER, IT SHOULD BE DIMEN-
C
C     *      W  WILL BE USED LATER FOR A WOPK VECTOR. -- COEF'S DIMENSION WILL
C*****       BE CHANED ALSO. - SO, FOR NOW ASSUME THE INPUT IS SORTED **** **** ****
C     *
          DIMENSION  X(14),Y(7), W(1), X0(1), Y0(1), CUBE(3), ROOT(3),
         *   ROOTI(3), X9(1), Y9(1)
           COMMON /COTAN/ TIN( 7,2), COEF(4, 7,2)
```

Figure 16. Program Listing - Main, CURVIT.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0    CD COUNT
      DO 1 I=1,MM
      X(I) = X9(I)
      X(I+7) = Y9(I)
 1    Y(I) = Y9(I)
      IF (MM .GE. 2) GO TO 10
      IF (MM .EQ. 0) Y = 0.
      DO  5  I=1,N
 5    Y0(I) = Y
      WRITE (6,100)      ( X0(I), Y0(I), I=1,N)
 100  FORMAT ( 94H0 PROBLEM WITH CURVE FITS (CURVIT) - LESS THAN TWO POI
     *NTS ON THIS CURVE. - INPUT X     OUTPUT Y, /(72X, 2E11.4, /) )
      RETURN
 10   CALL PARAM (MM, X,        2)
      DO  90  J=1,N
      TUM1=1
      DO  20  I=1,MM
      K=I-1
 20   IF( X0(J) .LT. X(I) ) GO TO 30
      IF( X0(J) .EQ. X(I) ) GO TO 48
      TUM1=-1
      I=  MM
 25   TUM1=-TUM1
      SLOPE = TIN(I,2)/TIN(I,1)* TUM1
      CONST = Y(I) - SLOPE*X(I)
      Y0(J) = SLOPE*X0(J) + CONST
      GO TO 90
 30   IF (I .EQ. 1) GO TO 25
 35   IF (X0(J) .EQ. X9(K)) GO TO 64
C         K REFER TO THE SECTION FROM WHICH WE NEED THE COEFFICIENTS.
      D= COEF(4,K,1)
      DO  40 I=1,3
 40   CUBE(I) = COEF(I,K,1)/D
      CUBE(1) = CUBE(1) - X0(J)/D
      CALL CUBIC (CUBE(3), CUBE(2), CUBE, ROOT, ROOTI )
      DO  50 I=1,3
      IF ( ABS(ROOT(I))   .LE. .0001) ROOT(I) = 0.
      IF ( ABS(ROOT(I)-1.).GT..0001) GO TO 49
 48   ROOT(I) = 1.
      Y0(J) = Y9(K+1)
      GO TO 90
 49   IF(ROOTI(I).NE.0.) GO TO 50
      IF(ROOT(I).LT.0.) GO TO 50
      IF(ROOT(I).GT.1.) GO TO 50
      GO TO 60
 50   CONTINUE
C     **  THERE IS NO SOLN.  **
      WRITE(6,101) (COEF(I,K,1), I=1,4), K, X0(J), (ROOT(I),ROOTI(I),I=1
     *,3)
 101  FORMAT ( 39H0    A ROOT FOR THE CUBIC EQUATION    X =, E11.4,3H + ,
     *  E11.4, 7H * T + , E11.4, 9H * T*T + , E11.4, 7H * T**3,13H  IN S
     *ECTION , I3, // 6X, 42H DOES NOT EXIST BETWEN 0. AND 1. WHEN X = ,
     *E13.5,47H AND THE ROOTS ARE -     REAL           IMAGINARY,(/77X,
     *E15.7, 2X,E15.7 ) )
      T = .5
```

Figure 17. Program Listing - CURVIT.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0
        GO TO 61
   64   T= 0.
        GO TO 61
   60   T = ROOT(I)
    61 YU(J) = COEF(1,K,2) + COEF(2,K,2)*T + COEF(3,K,2)*T*T +
      *         COEF(4,K,2)*T**3
   90   CONTINUE
        END
QIX6     FOR RDKU,RDKU
        SUBROUTINE RDKU(N)
C ***  THIS SUBR. READS THE PROPER TAPE (UNIT 8,9,10,11, OR 12)
         COMMON /BK1/ IDD,BB,AA,XA(5,5),DPSI,RR(5),OMEG,CC,NBLADE,MLIMRN,
      * MLIMDP,XFP(20),YFP(20),ZFP(20),GAMA,RO.BLADEL,B0,B1C,B1S,PUNCH,
      * LSPAN,FHOC(30),TCOP,SLOPE(10,5),OFFSET(10,5),KUNIT(5),IBURST,
      * IPS(5),ITRACK(5),FI(5,5),NCHAN(5,5),E3860P,NFT,ANG,KEY1,KEY2,
      * KEY3,NHH,CAPRF(20),THETAF(20),ALFAF(20),OPRONO,NCH(5),INTERM,
      * IREEL,NC,NTBDX(5,10),NSTATC(5,10),NSTATR(5,10),ISET(5),IREELS,
      * NOCH(5),LAZI
        COMMON /BK2/ NCYCLE,CYCLES,KU,NDIV(4),BMASK(6),NN(435),LIRS,
      * KTRACK,KBURST,KREC,ND1(144,10,5),ND2(144,10,5),XLO(7),XLM(7,40),
      * XMM(7,40),TEMP1(7),TEMP2(7),TEMP3(7),PI,AZMTH2(144),AZMTH(144),
      * DPRAD,AZRAD,NO,YES,NBLANK,TEE,BEE,DEE,GMARI(288,20),
      * HMARI(288,20),XO(20)
        DIMENSION CN(31,5,5),SN(30,5,5),AN(31,10,5),BN(30,10,5),
      * GMAR(144,5),HMAR(144,5)
        DIMENSION NNPS(219)
        EQUIVALENCE                  (ND2(5671),HMAR),(GMARI,AN),
      * (GMARI(1551),BN),(HMARI,CN),(HMARI(776),SN)
        EQUIVALENCE (FTRACK,KTRACK),(FBURST,KBURST),(FREC,KREC)
        EQUIVALENCE (ND1(5761),GMAR)
        GO TO (1,2),N
      1 LIM1 = 1
        LIM2 = 219
        GO TO 3
      2 LIM1 = 217
        LIM2 = 435
      3 I=KU-7
        GO TO (4,5,6,7,8),I
      4 READ(8)  (NN(I),I=LIM1,LIM2)
        GO TO 9
      5 READ(9)  (NN(I),I=LIM1,LIM2)
        GO TO 9
      6 READ(10)(NN(I),I=LIM1,LIM2)
        GO TO 9
      7 READ(11)(NN(I),I=LIM1,LIM2)
        GO TO 9
      8 READ(12)(NN(I),I=LIM1,LIM2)
        READ (13)  (NNPS(I),I=1,219)
        I=-1
        DO 20 J=LIM1,LIM2,3
        I=I+3
     20 NN(J)=NNPS(I)
      9 FTRACK = AND(NN(LIM2-2),BMASK(6))
        FBURST = AND(NN(LIM2-1),BMASK(6))
```

Figure 18. Program Listing - CURVIT, RDKU.

```
1       1         2         3         4         5         6         7         8
........0.........0.........0.........0.........0.........0.........0.........0
      FREC   = AND(NN(LIM2)  ,BMASK(6))
      IF(IDD.EQ.1)
     XWRITE(6,10) (NN(I),I=LIM1,LIM2)
   10 FORMAT(1H0, 19H(NN(I),I=LIM1,LIM2) / (2X,10013))
      RETURN
      END
@IXG   FOR INTERP,INTERP
      SUBROUTINE INTERP
C *** THIS SUBR. INTERPOLATES PRESSURE PULSE HARMONICS FOR UP TO 20 SPAN
C     STATIONS AND 288 AZIMUTHS.
       COMMON /BK1/ IDD,BB,AA,XA(5,5),DPSI,RR(5),OMEG,CC,NBLADE,MLIMRN,
     * MLIMDP,XFP(20),YFP(20),ZFP(20),GAMA,RO,BLADEL,B0,B1C,B1S,PUNCH,
     * LSPAN,FROC(30),TCOP,SLOPE(10,5),OFFSET(10,5),KUNIT(5),IBURST,
     * IRS(5),ITRACK(5),FI(5,5),NCHAN(5,5),E3860P,NFT,ANG,KEY1,KEY2,
     * KEY3,NHH,CAPRF(20),THETAF(20),ALFAF(20),OPRONO,NCH(5),INTERM,
     * IREEL,NC,NTBDX(5,10),NSTATC(5,10),NSTATR(5,10),ISET(5),IREELS,
     * NOCH(5),LAZI
      COMMON /BK2/ NCYCLE,CYCLES,KU,NDIV(4),BMASK(6),NN(435),LIRS,
     * KTRACK,KBURST,KREC,ND1(144,10,5),ND2(144,10,5),XLO(7),XLM(7,40),
     * XMM(7,40),TEMP1(7),TEMP2(7),TEMP3(7),PI,AZMTH2(144),AZMTH(144),
     * UPRAD,AZRAD,NO,YES,NBLANK,TEE,BEE,DEE,GMARI(288,20),
     * HMARI(288,20),XO(20)
      DIMENSION CN(31,5,5),SN(30,5,5),AN(31,10,5),BN(30,10,5),
     * GMAR(144,5),HMAR(144,5)
      EQUIVALENCE            (ND2(5671),HMAR),(GMARI,AN),
     * (GMARI(1551),BN),(HMARI,CN),(HMARI(776),SN)
      EQUIVALENCE (ND1(5761),GMAR)
      DIMENSION YO(20)
      T1=.199
      T2=.801
C *** WE FIRST DEFINE THE RADIAL STATION GRID XO(20)
      XO(1) = T1
      XO(LSPAN) = 1.
      K=LSPAN-1
      DEL=K
      DEL = T2/DEL
      DO 1 J=2,K
    1 XO(J)=XO(J-1)+DEL
      KKK = 1
      TEMP1(1) = 0.
      TEMP3(1) = 0.
      TEMP2(1) = T1
C *** RADIAL STATION LOOP   (ZERO AZIMUTH BEGIN)
      DO 2 K=1,5
      IF(IRS(K).EQ.0) GO TO 2
      KKK = KKK+1
      TEMP1(KKK) = GMAR(1,K)
      TEMP3(KKK) = HMAR(1,K)
      TEMP2(KKK) = RR(K)
    2 CONTINUE
      NOPTS1 = KKK+1
      TEMP1(NOPTS1) = 0.
      TEMP3(NOPTS1) = 0.
      TEMP2(NOPTS1) = 1.
```

Figure 19. Program Listing - RDKU, INTERP.

```
1        1         2         3         4         5         6         7         8
........0.........0.........0.........0.........0.........0.........0.........0   CD COUNT

      CALL CURVIT (NOPTS1,TEMP2,TEMP1,W,LSPAN,XO,YO)
      DO 3 K=1,LSPAN
    3 GMARI(1,K) = YO(K)
      CALL CURVIT(NOPTS1,TEMP2,TEMP3,W,LSPAN,XO,YO)
      DO 4 K=1,LSPAN
    4 HMARI(1,K) = YO(K)
      U = (DPSI/2.5) + .00001
      ISI = 0
      JJ = ISI
      JAZ2 = 1
      J = 3
      ISI2=ISI
      IF(ISI.EQ.0) ISI2=1
      LOW = ISI2+1
C *** AZIMUTH LOOP
      DO 5 JAZ=LOW,144,ISI2
      JAZ2 = JAZ2+1
      KKK=1
      DO 6 K=1,5
      IF(IRS(K).EQ.0) GO TO 6
      KKK = KKK+1
      TEMP1(KKK) = GMAR(JAZ,K)
      TEMP3(KKK) = HMAR(JAZ,K)
    6 CONTINUE
      CALL CURVIT(NOPTS1,TEMP2,TEMP1,W,LSPAN,XO,YO)
      IF(ISI.GE.1) J=JAZ2
      DO 7 K=1,LSPAN
    7 GMARI(J,K) = YO(K)
      CALL CURVIT(NOPTS1,TEMP2,TEMP3,W,LSPAN,XO,YO)
      DO 8 K=1,LSPAN
    8 HMARI(J,K) = YO(K)
      IF(JJ.NE.0) GO TO 5
      DO 9 K=1,LSPAN
      GMARI(J-1,K) = (GMARI(J,K)+GMARI(J-2,K))/2.
    9 HMARI(J-1,K) = (HMARI(J,K)+HMARI(J-2,K))/2.
      J=J+2
    5 CONTINUE
      IF(JJ.NE.0) RETURN
      J=J-2
      DO 10 K=1,LSPAN
      GMARI(J+1,K) = (GMARI(1,K) + GMARI(J   ,K))/2.
   10 HMARI(J+1,K) = (HMARI(1,K) + HMARI(J   ,K))/2.
      RETURN
      END
WIXG    FOR MERGES,MERGES
      SUBROUTINE MERGES
C *** THIS SUBR. PRODUCES DIFFERENTIAL PRESSURES FROM ABSOLUTE TOP AND BOTTOM
C     READINGS.
       COMMON /BK1/ IDD,BB,AA,XA(5,5),DPSI,RR(5),OMEG,CC,NBLADE,MLIMRN,
     * MLIMUP,XFP(20),YFP(20),ZFP(20),GAMA,RO,BLADEL,B0,B1C,B1S,PUNCH,
     * LSPAN,FROC(30),TCOP,SLOPE(10,5),OFFSET(10,5),KUNIT(5),IBURST,
     * IRS(5),ITRACK(5),FI(5,5),NCHAN(5,5),E3860P,NFT,ANG,KEY1,KEY2,
     * KEY3,NHH,CAPRF(20),THETAF(20),ALFAF(20),OPRONO,NCH(5),INTERM,
     * IREEL,NC,NTBOX(5,10),NSTATC(5,10),NSTATR(5,10),ISET(5),IREELS,
```

Figure 20. Program Listing - INTERP, MERGES.

```
1        1         2         3         4         5         6         7         8
........0.........0.........0.........0.........0.........0.........0........0   CD COUNT
     * NOCH(5),LAZI
      COMMON /BK2/ NCYCLE,CYCLES,KU,NDIV(4),BMASK(6),NN(435),LIRS,
     * KTRACK,KBURST,KREC,ND1(144,10,5),ND2(144,10,5),XLO(7),XLM(7,40),
     * XMM(7,40),TEMP1(7),TEMP2(7),TEMP3(7),PI,AZMTH2(144),AZMTH(144),
     * DPRAD,AZRAD,NO,YES,NBLANK,TEE,BEE,DEE,GMARI(288,20),
     * HMARI(288,20),XO(20)
      DIMENSION CN(31,5,5),SN(30,5,5),AN(31,10,5),BN(30,10,5),
     * GMAR(144,5),HMAR(144,5)
      EQUIVALENCE                  (ND2(5671),HMAR),(GMARI,AN),
     * (GMARI(1551),BN),(HMARI,CN),(HMARI(776),SN)
      EQUIVALENCE (ND1(5761),GMAR)
      INTEGER DEE,BEE
      DO 1 I=1,5
      DO 1 J=1,5
      CN(1,I,J) = 0.0
      DO 1  K=1,30
      CN(K+1,I,J) = 0.0
    1 SN(K,I,J) = 0.0
C *** SPAN LOOP
      ISWTCH=0
      DO 2 I=1,5
C *** CHORD LOOP
      DO 2 J=1,5
      ISW = 0
      IREEL = 0
    3 IREEL = IREEL+1
      NC = 0
    4 NC = NC+1
      IF(IDU.NE.1) GO TO 25
      WRITE(6,20) I,J,NC,IREEL,NSTATR(IREEL,NC),NSTATC(IREEL,NC),
     X     NTBDX(IREEL,NC)
   20 FORMAT(     6I13,5X,A6)
   25 IF(NC.GT.10) GO TO 3
      IF(ISWTCH.EQ.1) GO TO 15
      IF(NSTATR(IREEL,NC).EQ.0) GO TO 5
   15 IF(NSTATR(IREEL,NC).NE.I) GO TO 4
      IF(NSTATC(IREEL,NC).NE.J) GO TO 4
      IF(NTBDX(IREEL,NC).EQ.DEE) GO TO 6
      IF(NTBDX(IREEL,NC).EQ.BEE) GO TO 7
      IRTOP = IREEL
      NCTOP = NC
      ISW = ISW+1
      GO TO 8
    7 IRBOT = IREEL
      NCBOT = NC
      ISW = ISW+1
    8 IF(ISW.NE.2) GO TO 4
      CN(1,J,I) = AN(1,NCBOT,IRBOT) - AN(1,NCTOP,IRTOP)
      DO 10 K=1,30
      CN(K+1,J,I) = AN(K+1,NCBOT,IRBOT)-AN(K+1,NCTOP,IRTOP)
   10 SN(K,J,I) = BN(K,NCBOT,IRBOT)-BN(K,NCTOP,IRTOP)
      GO TO 2
C *** COLLECTIVE, LONGITUDINAL CYCLIC, AND LATERAL CYCLIC PITCH ANGLES FOUND
C     NEXT.
```

Figure 21. Program Listing - MERGES.

```
1        1         2         3         4         5         6         7         8
........0.........0.........0.........0.........0.........0.........0.........0     CD COUNT

      5 B0 = AN(1,NC,IREEL)
        B1C = AN(2,NC,IREEL)
        B1S = BN(1,NC,IREEL)
        ISWTCH=1
        IF(IDD.EQ.1) WRITE(6,20) B0,B1C,B1S,IREEL,I,J
        GO TO 4
      6 CN(1,J,I) = AN(1,NC,IREEL)
        DO 11 K=1,30
        CN(K+1,J,I) = AN(K+1,NC,IREEL)
     11 SN(K,J,I) = BN(K,NC,IREEL)
      2 CONTINUE
        RETURN
        END
@IX6     FOR      DFSRIE,DFSRIE
        SUBROUTINE DFSRIE(NP,NH,Y,A,B)                                  DFSRI
        DIMENSION Y(NP),A(1),B(1)                                       DFSRI
C                    ----------------------------------------------------
C                    NUMBER OF HARMONICS  MUST NOT EXCEED HALF
C                    THE NUMBER OF DATA POINTS INPUTED.
C                    ----------------------------------------------------
        NNH=MIN0(NH,NP/2)
C-----------------------------------------------------------------------
C       INITIALIZATION AND CONSTANTS.                                   DFSRI
C-----------------------------------------------------------------------
        SP=0.                                                           DFSRI
        CP=1.                                                           DFSRI
        RN=2./NP                                                        DFSRI
        B(1)=0.                                                         DFSRI
        A(1)=0.                                                         DFSRI
        ARG=RN*3.14159265                                               DFSRI
        C=COS(ARG)                                                      DFSRI
        S=SIN(ARG)                                                      DFSRI
C-----------------------------------------------------------------------
C       COMPUTE A FOR THE ZEROTH HARMONIC                               DFSRI
C-----------------------------------------------------------------------
        DO10I=1,NP                                                      DFSRI
10      A(1)=A(1)+Y(I)                                                  DFSRI
        A(1)=RN*A(1) /2.                                                DFSRI
C-----------------------------------------------------------------------
C       MAIN LOOP.                                                      DFSRI
C-----------------------------------------------------------------------
         DO 100 K=1,NNH
        X=C*CP-S*SP                                                     DFSRI
        SP=C*SP+S*CP
        CP=X                                                            DFSRI
        U=0.                                                            DFSRI
        V=0.                                                            DFSRI
C       COMPUTE RECURSIVE U,S                                           DFSRI
        DO20II=2,NP                                                     DFSRI
        J=NP-II+2                                                       DFSRI
        W=Y(J)+2.*CP*V-U                                                DFSRI
        U=V                                                             DFSRI
20      V=W                                                             DFSRI
        A(K+1)=RN*(Y(1)+CP*V-U)                                         DFSRI
```

Figure 22. Program Listing - MERGES, DFSRIE.

```
1         1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0   CD COUNT

100    B(K+1)=RN*SP*V                                                   DFSRI       973
       RETURN                                                           DFSRI       974
       END                                                              DFSRI       975
@IXG   FOR CUE,CUE                                                                  976
       SUBROUTINE CUE(N,FM,MFIELD)                                                  977
        COMMON /BK1/ IDD,BB,AA,XA(5,5),DPSI,RR(5),OMEG,CC,NBLADE,MLIMRN,            978
      * MLIMOP,XFP(20),YFP(20),ZFP(20),GAMA,R0,BLADEL,B0,B1C,B1S,PUNCH,             979
      * LSPAN,FROC(30),TCOP,SLOPE(10,5),OFFSET(10,5),KUNIT(5),IBURST,              980
      * IRS(5),ITRACK(5),FI(5,5),NCHAN(5,5),E3860P,NFT,ANG,KEY1,KEY2,              981
      * KEY3,NHH,CAPRF(20),THETAF(20),ALFAF(20),OPRONO,NCH(5),INTERM,              982
      * IREEL,NC,NTBDX(5,10),NSTATC(5,10),NSTATR(5,10),ISET(5),IREELS,             983
      * NOCH(5),LAZI                                                                984
       COMMON /BK2/ NCYCLE,CYCLES,KU,NDIV(4),BMASK(6),NN(435),LIRS,                 985
      * KTRACK,KBURST,KREC,ND1(144,10,5),ND2(144,10,5),XL0(7),XLM(7,40),            986
      * XMM(7,40),TEMP1(7),TEMP2(7),TEMP3(7),PI,AZMTH2(144),AZMTH(144),             987
      * DPRAD,AZRAD,NO,YES,NBLANK,TEE,BEE,DEE,GMARI(288,20),                        988
      * HMARI(288,20),X0(20)                                                        989
       COMMON /BK3/ SPLM(10,20),AZMTH3(288),                                        990
      * SPAN(20),                    PMRMS(10,20),                                  991
      * ICHANL(10,5),COSINE(288),SINE(288),BLADES,CARD,TAPE                         992
       EQUIVALENCE         *          (ND2(5671),HMAR),(GMARI,AN),                  993
      * (GMARI(1551),BN),(HMARI,CN),(HMARI(776),SN),(ND2,Q2)                        994
       DIMENSION CN(31,5,5),SN(30,5,5),AN(31,10,5),BN(30,10,5),                     995
      * GMAR(144,5),HMAR(144,5)                                                     996
      * ,Q1(288,20),Q2(288,20)                                                      997
       EQUIVALENCE (ND1(5761),GMAR),(ND1,Q1)                                        998
       T1=PI/30.                                                                    999
       T5=PI/180.                                                                   000
C ***  SPAN LOOP                                                                    001
       IF(IDD.NE.1) GO TO 7                                                         002
       WRITE(6,3) XFP                                                               003
       WRITE(6,3) YFP                                                               004
       WRITE(6,3) ZFP                                                               005
       WRITE(6,3) SPAN                                                              006
       WRITE(6,3) COSINE                                                            007
       WRITE(6,3) SINE                                                              008
       WRITE(6,3) AZMTH3                                                            009
       WRITE(6,3) OMEG,CC,GAMA,R0,B0,B1C,B1S,FM,BLADES,T1,T5                        010
     3 FORMAT(1H0/(2X,1P10E13.5))                                                   011
     7 DO 1 I=1,LSPAN                                                               012
C ***  AZIMUTH LOOP                                                                 013
       DO 1 J=1,LAZI                                                                014
       S = SQRT((XFP(MFIELD)-SPAN(I)*COSINE(J))**2 + (YFP(MFIELD)-SPAN(I)           015
      X *SINE(J))**2 + ZFP(MFIELD)**2)                                              016
       B =(B0 - GAMA*(SPAN(I)-R0) + B1C*COSINE(J) + B1S*SINE(J))*T5                 017
       SINB = SIN(B)                                                                018
       COSB = COS(B)                                                                019
       T4 = FM*BLADES*(AZMTH3(J)+(S*OMEG*T1)/CC)                                    020
       T2 = COS(T4)                                                                 021
       T3 = SIN(T4)                                                                 022
       T4= (FM*BLADES*OMEG/(CC*S**2))*T1                                            023
       IF(N.EQ.3) GO TO 2                                                           024
       Q1(J,I) =SPAN(I)* ((XFP(MFIELD)-SPAN(I)*COSINE(J))*SINB*SINE(J)-             025
      X (YFP(MFIELD)-SPAN(I)*SINE(J))*SINB*COSINE(J)+ZFP(MFIELD)*COSB)              026
```

Figure 23. Program Listing - DFSRIE, CUE.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0   CD COUNT

      Q2(J,I) = Q1(J,I)*(GMARI(J,I)*(-T2/S**3 - T4*T3) +
     X HMARI(J,I)*(T3/S**3 - T4*T2))
      IF(IDO.NE.1) GO TO 1
      IF(I.GT.2) GO TO 1
      IF(J.GT.20) GO TO 1
      WRITE(6,4) I,J,MFIELD
    4 FORMAT(1H0,6I13)
      WRITE(6,3) S,B,SINB,COSB,T2,T3,T4,GMARI(J,I),HMARI(J,I),
     X  Q1(J,I),Q2(J,I)
      GO TO 1
    2 Q2(J,I) = Q1(J,I)*(GMARI(J,I)*(-T3/S**3 + T4*T2) +
     X HMARI(J,I)*(-T2/S**3 - T4*T3))
    1 CONTINUE
      RETURN
      END
QIXG   FOR BLODAT,BLODAT
      BLOCK DATA
       COMMON /BK1/ IDO,BB,AA,XA(5,5),DPSI,RR(5),OMEG,CC,NBLADE,MLIMRN,
     * MLIMDP,XFP(20),YFP(20),ZFP(20),GAMA,R0,BLADEL,B0,B1C,B1S,PUNCH,
     * LSPAN,FROC(30),TCOP,SLOPE(10,5),OFFSET(10,5),KUNIT(5),IBURST,
     * IRS(5),ITRACK(5),FI(5,5),NCHAN(5,5),E3860P,NFT,ANG,KEY1,KEY2,
     * KEY3,NHH,CAPRF(20),THETAF(20),ALFAF(20),OPRONO,NCH(5),INTERM,
     * IREEL,NC,NTBDX(5,10),NSTATC(5,10),NSTATR(5,10),ISET(5),IREELS,
     * NOCH(5),LAZI
      COMMON /BK2/ NCYCLE,CYCLES,KU,NDIV(4),BMASK(6),NN(435),LIRS,
     * KTRACK,KBURST,KREC,ND1(144,10,5),ND2(144,10,5),XL0(7),XLM(7,40),
     * XMM(7,40),TEMP1(7),TEMP2(7),TEMP3(7),PI,AZMTH2(144),AZMTH(144),
     * DPRAD,AZRAD,NO,YES,NBLANK,TEE,BEE,DEE,GMARI(288,20),
     * HMARI(288,20),XO(20)
      COMMON /BK3/ SPLM(10,20),AZMTH3(288),
     * SPAN(20),                       PMRMS(10,20),
     * ICHANL(10,5),COSINE(288),SINE(288),BLADES,CARD,TAPE
      DIMENSION CN(31,5,5),SN(30,5,5),AN(31,10,5),BN(30,10,5),
     * GMAR(144,5),HMAR(144,5)
     * ,Q1(288,20),Q2(288,20)
      EQUIVALENCE                (ND2(5671),HMAR),(GMARI,AN),
     * (GMARI(1551),BN),(HMARI,CN),(HMARI(776),SN),(ND2,Q2)
      EQUIVALENCE (ND1(5761),GMAR),(ND1,Q1)
C IRS(I) IS AN INSTRUMENTED RADIAL STATION COUNTER, COUNTING FROM THE BLADE ROOT
C IF IRS(I)=0, THEN THAT STATION IS NO GOOD.
      DATA (IRS(I),I=1,5) /1,2,3,4,5/
C NCHAN(I,J) IS AN ISTRUMENTED CHORD STATION COUNTER J FOR EACH RADIAL STATION I
C IF CHORD STATION J IS NO GOOD, THEN NCHAN(I,J)=0
      DATA ((NCHAN(I,J),J=1,5),I=1,5)/1,2,3,4,5, 1,2,3,4,5, 1,2,3,4,5,
     X 1,2,3,4,5, 1,2,3,4,5/
C XA(I,J) IS THE FRACTIONAL DISTANCE ALONG THE CHORD FROM THE LEADING EDGE WHERE
C J=SPAN AND I=CHORD STATION.
      DATA ((XA(I,J),I=1,5),J=1,5)/ .042,.158,.300,.600,.910,
     X .042,.158,.300,.600,.910,      .042,.158,.300,.600,.910,
     X .042,.158,.300,.600,.910,      .042,.158,.300,.600,.910/
C NCH(I) IS THE TOTAL NO. OF CHORD STATIONS FOR RADIAL STATION I.
      DATA (NCH(I),I=1,5)/5,5,5,5,5/
C RR(I) IS THE FRACTIONAL RADIAL STATION MEASURED FROM THE HUB CENTER WHERE
C I=SPAN STATION.
```

Figure 24. Program Listing - CUE, BLODAT.

```
1        1         2         3                   5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0

      DATA (RR(I),I=1,5)/.40,.75,.85,.95,.98/
C FI(I,J) GAUSSIAN INTEGRATION FACTORS FOR RADIAL STATIONI, CHORD STATION J.
      DATA ((FI(I,J),J=1,5),I=1,5) /.1,.1,.222,.355,.222,
     X .1,.1,.222,.355,.222,         .1,.1,.222,.355,.222,
     X .1,.1,.222,.355,.222,         .1,.1,.222,.355,.222 /
      DATA (NDIV(I),I=1,4)/O 001 000 000 000, O 000 001 000 000,
     X O 000 000 001 000, O 000 000 000 001/,(BMASK(I),I=1,6)/
     X O 777 000 000 000, O 000 777 000 000, O 000 000 777 000,
     X O 000 000 000 777, O 777 777 000 000, O 000 000 777 777/,
     X YES/1HY/,NO/1HN/,TAPE/4HTAPE/,CARD/4HCARD/
      DATA TEE,BEE,DEE /1HT,1HB,1HD/
      END
QIXG   FOR INPUTA,INPUTA
      SUBROUTINE INPUTA
C THIS SUBR. RECEIVES CARD INPUT
       COMMON /BK1/ IDD,BB,AA,XA(5,5),DPSI,RR(5),OMEG,CC,NBLADE,MLIMRN,
     * MLIMOP,XFP(20),YFP(20),ZFP(20),GAMA,RO,BLADEL,B0,B1C,B1S,PUNCH,
     * LSPAN,FROC(30),TCOP,SLOPE(10,5),OFFSET(10,5),KUNIT(5),IBURST,
     * IRS(5),ITRACK(5),FI(5,5),NCHAN(5,5),E3860P,NET,ANG,KEY1,KEY2,
     * KEY3,NHH,CAPRF(20),THETAF(20),ALFAF(20),OPRONO,NCH(5),INTERM,
     * IREEL,NC,NTBCX(5,10),NSTATC(5,10),NSTATR(5,10),ISET(5),IREELS,
     * NOCH(5),LAZI
      COMMON /BK2/ NCYCLE,CYCLES,KU,NDIV(4),BMASK(6),NN(435),LIRS,
     * KTRACK,KBURST,KREC,ND1(144,10,5),ND2(144,10,5),XLO(7),XLM(7,40),
     * XMM(7,40),TEMP1(7),TEMP2(7),TEMP3(7),PI,AZMTH2(144),AZMTH(144),
     * DPRAD,AZRAD,NO,YES,NBLANK,TEE,BEE,DEE,GMARI(288,20),
     * HMARI(288,20),XO(20)
      COMMON /BK3/ SPLM(10,20),AZMTH3(288),
     * SPAN(20),                          PMRMS(10,20),
     * ICHANL(10,5),COSINE(288),SINE(288),BLADES,CARD,TAPE
      EQUIVALENCE                     (ND2(5671),HMAR),(GMARI,AN),
     * (GMARI(1551),BN),(HMARI,CN),(HMARI(776),SN),(ND2,Q2)
      DIMENSION CN(31,5,5),SN(30,5,5),AN(31,10,5),BN(30,10,5),
     * GMAR(144,5),HMAR(144,5)
     * ,Q1(288,20),Q2(288,20)
      EQUIVALENCE (ND1(5761),GMAR),(ND1,Q1)
      READ(5,1) (NN(I),I=1,14)
    1 FORMAT( 13A6,A2 )
      WRITE(6,2) (NN(I),I=1,14)
    2 FORMAT(1H1,25X,13A6,A2)
      READ(5,3) BB,AA,BLADEL,GAMA,RO,CC,OMEG,DPSI,NBLADE,MLIMOP,MLIMRN,
     * LSPAN,IREELS,TCOP,PUNCH,INTERM,IDD
    3 FORMAT( 8E7.0,1X,I1,3(1X,I2),1X,I1,1X,A4,2(1X,A1),1X,I1)
      IF(TCOP.EQ.CARD) GO TO 45
      DO 100 I=1,5
      DO 100 JJ=1,10
      NSTATC(I,JJ) = 100
  100 NSTATR(I,JJ) = 100
      DO 16 J=1,IREELS
      READ(5,4) IREEL,ITRACK(IREEL),ISET(IREEL),KUNIT(IREEL)
      WRITE(6,77)
     X            IREEL,ITRACK(IREEL),ISET(IREEL),KUNIT(IREEL)
   77 FORMAT( 5I13)
    4 FORMAT(I1,2(1X,I2),6X,I2)
```

Figure 25. Program Listing - BLODAT, INPUTA.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0
      NOCH(IREEL)= 0
    6 READ(5,5) NC,NTBDX(IREEL,NC),NSTATC(IREEL,NC),NSTATR(IREEL,NC),
     * SLOPE(NC,IREEL),OFFSET(NC,IREEL),NCEND
    5 FORMAT(2X,I2,1X,A1,2(1X,I1),1X,E13.1,3X,E13.1,39X,I1)
      NOCH(IREEL) = NOCH(IREEL)+1
      K=NOCH(IREEL)
      ICHANL(K,JJ) = NC
      IF(NCEND.EQ.0) GO TO 6
   16 CONTINUE
      READ(5,7) (FROC(J),J=1,30)
    7 FORMAT(6E13.1,2X)
   45 READ(5,8) E3860P,OPRONO,NFT
    8 FORMAT(1X,2(1X,A1),2X,I2)
      IF(E3860P.NE.YES)GO TO 9
      READ(5,10) ANG,NHH,KEY1,KEY2,KEY3
   10 FORMAT( E7.0,4(2X,I2))
    9 DO 11 I=1,NFT
      IF(E3860P.NE.YES)GO TO 12
      READ(5,13) CAPRF(I),THETAF(I),ALFAF(I),XFP(I),YFP(I),ZFP(I)
   13 FORMAT( 3E10.1,20X,3E10.1)
      GO TO 11
   12 READ(5,14) XFP(I),YFP(I),ZFP(I)
   14 FORMAT( 50X,3E10.1)
   11 CONTINUE
C *** NOW THE INPUT IS PRINTED OUT.
      WRITE(6,20) BB,RO,AA,CC,BLADEL,OMEG,DPSI,GAMA
   20 FORMAT(1H0,1X, 28HBLADE THICKNESS (IN)      = , E10.4, 8X,
     1 35HZERO TWIST BLADE STA.      (IN)    = , E10.4 //  2X,
     2 28HBLADE CHORD      (IN)      = ,E10.4, 8X,35HSPEED OF SOUND
     3   (IN/SEC)  = ,E10.4 //  2X,28HBLADE LENGTH      (IN)        =
     3 , E10.4,8X,
     4 35HROTOR ROT. SPEED           (RPM)   = ,E10.4  //  48X,35HAZIMUTH
     5INCREMENT          (DEG)    = ,E10.4 /  2X, 28HBLADE TWIST RATE (DEG/
     6IN) = ,E10.4 )
      WRITE(6,21) NBLADE,TCOP,MLIMOP,PUNCH,MLIMRN,INTEPM,LSPAN,IREELS
   21 FORMAT(1H0,17H NUMBER OF BLADES, 32X,2H= , I2, 14X, 18HTAPE / CARD
     1 OPTION, 15X, 2H= , A4 // 2X, 49HNO. OF HARMONICS TO REPRESENT PRE
     2SSURE CYCLES    =  , I3, 14X, 35HPRESSURE HARMONIC PUNCH OPTION    =
     3 , A1 // 2X, 28HNO. OF ROTOR NOISE HARMONICS, 20X,2H= , I2, 14X,
     4 26HINTERMEDIATE OUTPUT OPTION, 7X, 2H= , A1 // 2X, 33HNO. OF INTE
     5RPOLATED SPAN STATIONS, 15X, 2H= , I2 // 2X, 23HTOTAL NO. OF TAPE
     6REELS, 25X,2H= , I2 /  )
      IF(TCOP.EQ.CARD) GO TO 46
      DO 22 IREEL=1,IREELS
      WRITE(6,23) IREEL,ITRACK(IREEL),ISET(IREEL),KUNIT(IREEL)
   23 FORMAT(1H0,1X, 11HREEL NO. = ,I1, 4X,12HTRACK NO. = , I2, 4X,
     1 10HSET NO. = , I2, 4X, 24HLOGICAL TAPE UNIT NO. = , I2 //  8X,
     2  7HCHANNEL, 24X, 5HSLOPE, 14X, 6HOFFSET )
      K=NOCH(IREEL)
      DO 22 I=1,K
      NC = ICHANL(I,IREEL)
      WRITE(6,24) NC,NTBDX(IREEL,NC),NSTATC(IREEL,NC),NSTATR(IREEL,NC),
     1 SLOPE(NC,IREEL),OFFSET(NC,IREEL)
   24 FORMAT( 10X,I2,6X,A1,6X,I1,6X,I1,6X,1PE12.6,7X,  E12.6  )
```

Figure 26. Program Listing - INPUTA.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0   CD COUNT

      SLOPE(NC,IREEL) = SLOPE(NC,IREEL)/256.
   22 CONTINUE
      WRITE(6,25)
   25 FORMAT(//// 3X, 8HHARMONIC, 5X,18HFREQ. CORR. FACTOR, 19X,8HHARMON
     1IC, 5X, 18HFREQ. CORR. FACTOR // )
      DO 26 J=1,15
      JJ = J+15
      WRITE(6,63) J,FROC(J),JJ,FROC(JJ)
   63 FORMAT( 10X,I2,13X,1PE11.4,25X,I2,13X,1PE11.4)
   26 CONTINUE
   46 WRITE(6,27) E386OP,OPRONO,NFT
   27 FORMAT( 2H0 , 62HOPTION TO USE PROGRAM E386 (THEORETICAL CONST. PR
     1ESSURE PULSE) ,8X,2H= , A1 //  2X, 59HOPTION TO USE ROTOR NOISE PR
     2OGRAM (MEASURED PRESSURE PULSE) ,11X, 2H= , A1 //  2X, 19HNO. OF F
     3IELD POINTS, 51X, 1H= , I2 //  )
      IF(E386OP.NE.YES)GO TO 28
      WRITE(6,29) ANG,NHH,KEY1,KEY2,KEY3
   29 FORMAT(2X, 43HINCR. OF INTEGRATION USED IN E386 (DEG.) = , F7.4,
     1 4X, 28HNO. OF AIR LOAD HARMONICS = ,I2,4X, 6HKEY1= ,I2,2X,6HKEY2=
     2 ,I2,2X,6HKEY3= ,I2///)
C *** FIELD POINTS PRINTED OUT NEXT.
   28 IF(E386OP.NE.YES.AND.OPRONO.NE.YES) GO TO 60
      WRITE(6,36)
   36 FORMAT(    25X,17HE386 FIELD POINTS, 32X,24HROTOR NOISE FIELD POINT
     1S //   6X,2HFP,7X,   6HR (FT),7X, 24HTHETA (DEG)   ALPHA (DEG), 9X,
     2 2HFP, 7X, 6HX (IN), 7X,6HY (IN),7X,6HZ (IN) / )
      GO TO 31
   60 IF(E386OP.NE.YES) GO TO 30
      WRITE(6,37)
   37 FORMAT(    25X,17HE386 FIELD POINTS // 6X,2HFP, 7X, 6HR (FT), 7X,
     1 24HTHETA (DEG)   ALPHA (DEG) / )
      GO TO 31
   30 WRITE(6,38)
   38 FORMAT( 74X, 24HROTOR NOISE FIELD POINTS // 61X, 2HFP, 7X, 6HX (IN
     1), 7X,6HY (IN),7X,6HZ (IN) /  )
   31 DO 32 I=1,NFT
      IF(E386OP.NE.YES.AND.OPRONO.NE.YES) GO TO 33
      WRITE(6,39) I,CAPRF(I),THETAF(I),ALFAF(I),I,XFP(I),YFP(I),ZFP(I)
   39 FORMAT( 6X,I2,4X, 3(3X,E10.4),10X,I2,2X, 3(3X,E10.4)  )
      GO TO 32
   33 IF(E386OP.NE.YES) GO TO 34
      WRITE(6,39) I,CAPRF(I),THETAF(I),ALFAF(I)
      GO TO 32
   34 WRITE(6,40) I,XFP(I),YFP(I),ZFP(I)
   40 FORMAT( 61X,I2,2X, 3(3X,E10.4) )
   32 CONTINUE
      RETURN
      END
QIX6   FOR UNPACK,UNPACK
      SUBROUTINE UNPACK
C *** THIS SUBR. UNPACKS A CYCLE NN(435) TO FORM THE ARRAY ND1(144,10,IREEL)
C     WHERE THE FIRST SUBSCRIPT REPRESENTS AZIMUTH, AND THE SECOND ARRAY
C     REPRESENTS CHANNEL NO.
       COMMON /BK1/ IDD,BB,AA,XA(5,5),DPSI,RR(5),OMEG,CC,NBLADE,MLIMRN,
```

Figure 27. Program Listing - INPUTA, UNPACK.

```
1        1         2         3         4         5         6         7         8
........0.........0.........0.........0.........0.........0.........0.........0
     * MLIMUP,XFP(20),YFP(20),ZFP(20),GAMA,RO,BLADEL,B0,B1C,B1S,PUNCH,
     * LSPAN,FROC(30),TCOP,SLOPE(10,5),OFFSET(10,5),KUNIT(5),IBURST,
     * IRS(5),ITRACK(5),FI(5,5),NCHAN(5,5),E386OP,NFT,ANG,KEY1,KEY2,
     * KEY3,NHH,CAPRF(20),THETAF(20),ALFAF(20),OPRONO,NCH(5),INTERM,
     * IREEL,NC,NTBOX(5,10),NSTATC(5,10),NSTATR(5,10),ISET(5),IREELS,
     * NOCH(5),LAZI
      COMMON /BK2/ NCYCLE,CYCLES,KU,NDIV(4),BMASK(6),NN(435),LIRS,
     * KTRACK,KBURST,KREC,ND1(144,10,5),ND2(144,10,5),XLO(7),XLM(7,40),
     * XMM(7,40),TEMP1(7),TEMP2(7),TEMP3(7),PI,AZMTH2(144),AZMTH(144),
     * DPRAD,AZRAD,NO,YES,NBLANK,TEE,BEE,DEE,GMARI(288,20),
     * HMARI(288,20),XO(20)
      EQUIVALENCE                  (ND2(5671),HMAR),(GMARI,AN),
     * (GMARI(1551),BN),(HMARI,CN),(HMARI(776),SN)
      DIMENSION CN(31,5,5),SN(30,5,5),AN(31,10,5),BN(30,10,5),
     * GMAR(144,5),HMAR(144,5)
      EQUIVALENCE (ND1(5761),GMAR)
      DATA SIN/O 400 000 000 000/
      EQUIVALENCE  (V2,IV2)
      WRITE(6,6) NN
    6 FORMAT(2X,10013)
      NW = 0
C *** AZIMUTH POINT LOOP
      DO 1 I=1,144
      NCT = 0
C *** WORDS IN A FRAME LOOP
      DO 1 J=1,3
      NW = NW+1
      N10 = 5
C *** DATA WORDS TO UNPACK LOOP
      DO 1 K=1,4
      N10 = N10-1
      IF(J.EQ.3.AND.K.GT.2) GO TO 1
      NCT = NCT+1
      N1 = NN(NW)
      IF(K.EQ.1) GO TO 2
      N1 = N1*NDIV(N10)
    2 N1 = N1/NDIV(1)
      IV2=N1
      V2=AND(V2,SIN)
      IV2=IV2/2
      IF(IV2.NE.0) N1=N1-1
      ND1(I,NCT,IREEL) = N1
    1 CONTINUE
      IF(IDD.NE.1.AND.NCYCLE.GT.0) RETURN
      WRITE(6,5) IREEL,(ND1(1,K,IREEL),K=1,10)
    5 FORMAT(1H0,  6HIREEL=,I3,10X,
     X 18HND1(144,10,IREEL)  /2X,10I13)
      RETURN
      END
@IXG  FOR PARAM,FARAM
      SUBROUTINE PARAM (N, P,       IJ )
      DIMENSION G( 7), P( 7,2),DEL( 7,2),DIST( 7),A( 7, 8),Q( 7,2)
       COMMON /COTAN/   T( 7,2), COE (4, 7,2)
      N1 = N-1
```

Figure 28. Program Listing - UNPACK, PARAM.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0    CD COUNT

      N2 = N-2
      N3 = N-3
      NO=N2
      IGO = 2
      DO  15 I=1,N1
      DO 10 J=1,2
   10 DEL(I,J) =  P(I+1,J) - P(I,J)
   15 DIST(I)  =  SQRT(DEL(I,1)**2 + DEL(I,2)**2)
      DO  20 I=1,N
      DO  20 J=1,N
   20 A(I,J) = 0.
      A(1,3) = DIST(1)
      A(N2,N2) = DIST(N1)
      DO  30  I=2,N3
      A(I,I)    = DIST(I+1)
      A(I,I+1) = 2.*(DIST(I)+DIST(I+1))
      A(I,I+2) = DIST(I)
      DO 30 J=1,2
   30 Q(I,J)    = 3.*(DIST(I)/DIST(I+1)*DEL(I+1,J)+DIST(I+1)/DIST(I)*DEL(
     *  I,J))
   12 A(1,2) = 2.* DIST(1) + DIST(2)*1.5
C  12 A(1,2) = 2.*(DIST(1) + DIST(2))
      DO 33 J=1,2
C 33  Q(1,J) = 3.*(DIST(1)/DIST(2)*DEL(2,J)+DIST(2)/DIST(1)*DEL(1,J)) -
  33  Q(1,J) = 3.*(DIST(1)/DIST(2)*DEL(2,J)+DIST(2)/DIST(1)*DEL(1,J)/2.)
C    * DIST(2)* T(1,J)
C  22 A(N2, N1 ) = 2.*(DIST(N2 ) + DIST(N1 ))
   22 A(N2, N1 ) =1.5* DIST(N2 ) + DIST(N1 )*2.
      DO 27 J=1,2
   27 Q(N2, J)    =1.5*(DIST(N2 )/DIST(N1 )*DEL(N1, J)    +DIST(N1 )/DIST
C  27 Q(N2, J)     = 3.*(DIST(N2 )/DIST(N1 )*DEL(N1, J)    +DIST(N1 )/DIST
     *(N2 )*DEL(N2, J))
C    *(N2 )*DEL(N2, J)) - DIST(N2 )* T(N,J)
   17 DO 45 J=1,2
      DO  36  I=1,NO
   36 G(I)=Q(I,J)
      CALL TRIDAG(A(1,2),G,NO,T(2,J))
      T(1,J) = 1.5/DIST*DEL(1,J) - .5*T(2,J)
      T(N,J) = 1.5/DIST(N1)*DEL(N1,J) - .5*T(N1,J)
   44 DO  45  I=1,N1
      COE(4,I,J)=-2.*DEL(I,J) + DIST(I)*( T(I+1,J)+T(I,J) )
      COE(3,I,J)= 3.*DEL(I,J) - DIST(I)*( T(I+1,J)+2.*T(I,J) )
      COE(2,I,J)= DIST(I)*T(I,J)
   45 COE(1,I,J)= P(I,J)
      RETURN
      END
QIXG  FOR TRIDAG,TRIDAG
      SUBROUTINE TRIDAG(A,G,K1,Z )
      DIMENSION A( 7,8),G(7),Z(7)
    1 FORMAT (10X,50HT=0. .OR. S=0. IN TRIDAG.  CANNOT DIVIDE BY S OR T)
C
C     PURPOSE
C         TO SOLVE THE TRIDIAGONAL MATRIX EQUATION
C
```

Figure 29. Program Listing - PARAM, TRIDAG.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0   CD COUNT
C          ****************-- ***        ***
C          *   *   *       - * *         * *
C          * S * R *       - * *         * *
C          *   *   *       - * *         * *
C          *************   - * *         * *
C          *   *   *   *   - * *         * *
C          * T * S * R *   - * *         * *
C          *   *   *   *   - * *  ---    * *
C          ****************   *Z*        *G*
C          -   *   *   *   * * *  ---    * *
C          -   * T * S * R * * *         * *
C          -   *   *   *   * * *         * *
C          -   ************* * *         * *
C          -       *   *   * * *         * *
C          -       * T * S * * *         * *
C          -       *   *   * * *         * *
C          ----------*********** ***     ***
C
C     FOR THE SOLUTIONS Z, WHERE GAUSS IS NOT USED AND THE SUB-MATRICES
C     ALL CONSIST OF A SINGLE ELEMENT.
C
C     DESCRIPTION OF PARAMETERS
C         A -- MATRIX WHOSE THREE DIAGONALS CENTERED ON THE PRINCIPAL
C                DIAGONAL BECOME THE TRIDIAGONAL MATRIX.
C         G -- RIGHT HAND SIDE OF EQUATION.  VECTOR OF LENGTH K1.
C         K1-- NUMBER OF ROWS IN THE MATRIX A.
C         Z -- SOLUTIONS, VECTOR (COLUMN) OF LENGTH K1 .
C
C
C     FIND THE LAST SOLUTION, Z(K1)
C
      S= A(1,1)
      R= A(1,2)
      IF (S .EQ. 0.) GO TO 25
      C= G(1)/S
      D= -R/S
      K2 = K1-1
      DO 10 I=2,K2
      T = A(I,I-1)
      S = A(I,I)
      R = A(I,I+1)
      DENOM = T*D+S
      C = (G(I)-C*T)/DENOM
      D = -R/DENOM
   10 CONTINUE
      S= A(K1,K1)
      T= A(K1,K1-1)
      Z(K1)=(G(K1)-T*C)/(T*D+S)
C
C     CALCULATE OTHER SOLUTIONS, PROCEEDING BACKWARDS
C
      IF(T .EQ. 0. ) GO TO 25
      Z(K1-1) = ( G(K1)-Z(K1)*S)/T
   15 K3=K2-1
```

Figure 30. Program Listing - TRIDAG.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0

      DO 20 I=2,K3
      J = K1-I
      S = A(J+1,J+1)
      R = A(J+1,J+2)
      T = A(J+1,J)
      IF(T .EQ. 0. ) GO TO 25
      Z(J) = ( G(J+1)-S*Z(J+1)-R*Z(J+2))/T
   20 CONTINUE
      Z(1) = (G(1)-A(1,2)*Z(2))/A(1,1)
      RETURN
   25 WRITE(6,1)
      RETURN
      END
@IXG  FOR CUBIC,CUBIC
      SUBROUTINE CUBIC ( P,Q,R , ROOT, ROOTI )
C   CUBIC  FINDS  THE REAL + COMPLEX ROOTS OF    (X**3)+P*(X**2)+Q*(X) +R =0
      DIMENSION                      ROOT(3),ROOTI(3)
   90 DO 220 I=1,3
      ROOT(I)= 0.
  220 ROOTI(I)=0.
      P3  = P/3.
      SMALLA  =  Q - P*P3
      SMALLB  =  2. *P3**3 - P3* Q +R
      AD3  =  SMALLA/3.
      SB2  =  SMALLB/2.
      B4 =    SB2**2
      A27 =    AD3 **3
      SMALLC =  B4 + A27
      IF (SMALLC)14 , 1 ,5
    1 XA=SQRT (-AD3)
      IF (SMALLB) 3,4,4
    3 XA=-XA
    4 ROOT(1) =XA-P3
      ROOT(2) = ROOT(1)
      ROOT(3) = -XA-XA-P3
      GO TO 22
    5 POWER = 1./ 3.
      B2 =  - SMALLB / 2.
      SBA= SQRT  ( SMALLC)
      BIGA = B2 + SBA
      BIGB =  B2 -SBA
      IF ( BIGA ) 6  , 7 , 8
    6 BIGA1 =-((-BIGA )** POWER  )
      GO TO 9
    7 BIGA1 =0.
      GOTO  9
    8 BIGA1 =   ( BIGA)** POWER
    9 IF ( BIGB )10 , 11, 12
   10 BIGB1 =-((-BIGB) ** POWER  )
      GO TO 13
   11 BIGB1 = 0.
      GO TO 13
   12 BIG B1  = (BIGB) ** POWER
   13 AB = BIGA1+BIGB1
```

Figure 31. Program Listing - TRIDAG, CUBIC.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0
      ROOT (1) = AB-P3
      ROOTI(1) =   0.
      ROOT (2) = -AB/2.-P3
      ROOT (3) =    ROOT(2)
      ROOTI(2) =  SQRT (3.)/2. *( BIGA1 - BIGB1)
      ROOTI(3) =   - ROOTI (2)
      GO TO 22
   14 RAD  = 57.2957795
      CON  = 120./ RAD
      A3   =  SQRT  ( -AD3)
      IF  (SMALLB ) 15, 16, 17
   15 COT = 0.
      CP = 1.
      GO TO 18
   16 PH3 = 30./ RAD
      GO TO 19
   17 COT  = 180. /RAD
      CP= -1.
   18 B4A27 =  - B4 /A27
      COSPHI =   CP* SQRT ( B4A27)
      XK    = SQRT  ( 1.- B4A27)
      PHI   = ATAN ( XK/ COSPHI )
      PH3 = (COT + PHI*CP/3.)
   19 DO  20  I= 1,3
   20 ROOTI(I) = 0.
      AK = A3+ A3
      ANGLE  =PH3
      DO 21 I = 1,3
      ROOT (I) = AK * COS  (ANGLE)-P3
   21 ANGLE = ANGLE +CON
   22 RETURN
      END
@IXG   FOR OUTSPL,OUTSPL
      SUBROUTINE OUTSPL
       COMMON /BK1/ IDD,BB,AA,XA(5,5),DPSI,RR(5),OMEG,CC,NBLADE,MLIMRN,
     * MLIMDP,XFP(20),YFP(20),ZFP(20),GAMA,RO,BLADEL,B0,B1C,B1S,PUNCH,
     * LSPAN,FROC(30),TCOP,SLOPE(10,5),OFFSET(10,5),KUNIT(5),IBURST,
     * IRS(5),ITRACK(5),FI(5,5),NCHAN(5,5),E3860P,NFT,ANG,KEY1,KEY2,
     * KEY3,NHH,CAPRF(20),THETAF(20),ALFAF(20),OPRONO,NCH(5),INTERM,
     * IREEL,NC,NTBDX(5,10),NSTATC(5,10),NSTATR(5,10),ISET(5),IREELS,
     * NOCH(5),LAZI
      COMMON /BK2/ NCYCLE,CYCLES,KU,NDIV(4),BMASK(6),NN(435),LIRS,
     * KTRACK,KBURST,KREC,ND1(144,10,5),ND2(144,10,5),XLQ(7),XLM(7,40),
     * XMM(7,40),TEMP1(7),TEMP2(7),TEMP3(7),PI,AZMTH2(144),AZMTH(144),
     * DPRAD,AZRAD,NO,YES,NBLANK,TEE,BEE,DEE,GMARI(288,20),
     * HMARI(288,20),XO(20)
      COMMON /BK3/ SPLM(10,20),AZMTH3(288),
     * SPAN(20),                     PMRMS(10,20),
     * ICHANL(10,5),COSINE(288),SINE(288),BLADES,CARD,TAPE
      DIMENSION CN(31,5,5),SN(30,5,5),AN(31,10,5),BN(30,10,5),
     * GMAR(144,5),HMAR(144,5)
     * ,Q1(288,20),Q2(288,20)
      EQUIVALENCE                 (ND2(5671),HMAR),(GMARI,AN),
     * (GMARI(1551),BN),(HMARI,CN),(HMARI(776),SN),(ND2,Q2)
```

Figure 32. Program Listing - CUBIC, OUTSPL.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0
      EQUIVALENCE (ND1(5761),GMAR),(ND1,Q1)
C *** HARMONIC LOOP
      DO 1 I=1,MLIMRN,2
      WRITE(6,2) I
    2 FORMAT(1H1, 28X, 29HROTATIONAL NOISE PROGRAM E676 / 8X,
     X 10HHARMONIC =, I3 )
      WRITE(6,3)
    3 FORMAT(1H0, 8X, 5HFIELD, 11X, 28HFIELD POINT COORDINATES (IN),
     X 16X, 20HSOUND PRESSURE LEVEL / 8X, 5HPOINT, 10X,1HX,14X,1HY,
     X 14X,1HZ, 20X,  8HDECIBELS / )
C *** FIELD POINT LOOP
      DO 4 J=1,NFT
    4 WRITE(6,5) J,XFP(J),YFP(J),ZFP(J),SPLM(I,J)
    5 FORMAT( 9X,I2,2X, 3(5X,1PE10.4),15X, 1PE10.4 )
      IF(I.GE.MLIMRN) GO TO 7
      K=I+1
      WRITE(6,6) K
    6 FORMAT(1H2  / 8X,10HHARMONIC =,I3 )
      WRITE(6,3)
C *** FIELD POINT LOOP
      DO 8 J=1,NFT
    8 WRITE(6,5) J,XFP(J),YFP(J),ZFP(J),SPLM(K,J)
    1 CONTINUE
    7 RETURN
      END
QIXG   FOR      AVQUAD,AVQUAD
      SUBROUTINE AVQUAD (N,X,Y,AREA)
C     INTEGRATION BY AVERAGED QUADRATICS BASED ON LAGRANGE INTERPOLATION
      DIMENSION X(12),Y(12)
      AREA=0.
      T1=Y(1)/((X(1)-X(2))*(X(1)-X(3)))
      T2=Y(2)/((X(2)-X(1))*(X(2)-X(3)))
      T3=Y(3)/((X(3)-X(1))*(X(3)-X(2)))
      A2=T1+T2+T3
      B2=-(T1*(X(2)+X(3))+T2*(X(1)+X(3))+T3*(X(1)+X(2)))
      C2=T1*X(2)*X(3)+T2*X(1)*X(3)+T3*X(1)*X(2)
      AREA=AREA+(A2/3.)*((X(2)**3)-(X(1)**3))+(B2/2.)*((X(2)**2)-(X(1)**
     12))+C2*(X(2)-X(1))
      N2=N-2
      DO 101 K=2,N2
      A1=A2
      B1=B2
      C1=C2
      T1=Y(K)/((X(K)-X(K+1))*(X(K)-X(K+2)))
      T2=Y(K+1)/((X(K+1)-X(K))*(X(K+1)-X(K+2)))
      T3=Y(K+2)/((X(K+2)-X(K))*(X(K+2)-X(K+1)))
      A2=T1+T2+T3
      B2=-(T1*(X(K+1)+X(K+2))+T2*(X(K)+X(K+2))+T3*(X(K)+X(K+1)))
      C2=T1*X(K+1)*X(K+2)+T2*X(K)*X(K+2)+T3*X(K)*X(K+1)
      A=(A1+A2)/2.
      B=(B1+B2)/2.
      C=(C1+C2)/2.
  101 AREA=AREA+(A/3.)*((X(K+1)**3)-(X(K)**3))+(B/2.)*((X(K+1)**2)-(X(K)
     1**2))+C*(X(K+1)-X(K))
```

Figure 33. Program Listing -OUTSPL, AVQUAD.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0   CD COUNT

      AREA=AREA+(A2/3.)*((X(N)**3)-(X(N-1)**3))+(B2/2.)*((X(N)**2)-(X(N-
     11)**2))+C2*(X(N)-X(N-1))
      RETURN
      END
WIXG   FOR       E386RN,E386RN
      SUBROUTINE E386RN
C     ACOUSTIC PRESSURE       V.BERECZ FOR R.KING     DECK E386
       COMMON /BK1/ IDD,BB,AA,XA(5,5),DPSI,RR(5),OMEG,CC,NBLADE,MLIMRN,
     * MLIMOP,XFP(20),YFP(20),ZFP(20),GAMA,R0,BLADEL,B0,B1C,B1S,PUNCH,
     * LSPAN,FROC(30),TCOP,SLOPE(10,5),OFFSET(10,5),KUNIT(5),IBURST,
     * IRS(5),ITRACK(5),FI(5,5),NCHAN(5,5),E386OP,NFT,ANG,KEY1,KEY2,
     * KEY3,NHH,CAPRF(20),THETAF(20),ALFAF(20),OPRONO,NCH(5),INTERM,
     * IREEL,NC,NTBOX(5,10),NSTATC(5,10),NSTATR(5,10),ISET(5),IREELS,
     * NOCH(5),LAZI
      COMMON /BK2/ NCYCLE,CYCLES,KU,NDIV(4),BMASK(6),NN(435),LIRS,
     * KTRACK,KBURST,KREC,ND1(144,10,5),ND2(144,10,5),XLO(7),XLM(7,40),
     * XMM(7,40),TEMP1(7),TEMP2(7),TEMP3(7),PI,AZMTH2(144),AZMTH(144),
     * DPRAD,AZRAD,NO,YES,NBLANK,TEE,BEE,DEE,GMARI(288,20),
     * HMARI(288,20),XO(20)
      DIMENSION CN(31,5,5),SN(30,5,5),AN(31,10,5),BN(30,10,5),
     * GMAR(144,5),HMAR(144,5)
      EQUIVALENCE                  (ND2(5671),HMAR),(GMARI,AN),
     * (GMARI(1551),BN),(HMARI,CN),(HMARI(776),SN)
      EQUIVALENCE (ND1(5761),GMAR)
      DIMENSION             Q(721,8),R(8),V8(8),V8I(8),
     1 V25(721),V25I(721),PSI(721),PRAD(721)
C
C     READ FLT. COND. PARAMETERS AND BLADE SECTION LOADING, PRINT SAME.
C
      KBN=NBLADE
      EQUIVALENCE
     X       (CH,AA),(SOS,CC),(B01,B0),(B1,B1C),(B11,B1S),(G,GAMA),
     X (NHAR,MLIMRN),                (NFT,NFP),(OMG,OMEG)
      NRAD = LIRS+2
      GATC1=B0
      GATC2=B1C
      GATC3=B1S
      GATC4=GAMA
      GATC5=OMEG
      SOS = SOS/12.0
      J=1
      R(1)=0.
      DO 730 I=1,5
      J=J+1
      IF(IRS(I).EQ.0) GO TO 730
      R(J)=RR(I)*BLADEL
  730 CONTINUE
      J=J+1
      R(J)=BLADEL
      RAD= 1./57.2957795
      NP=(360./ANG)+1.001
      NT=NP-1
      PSI(1)= 0.
      PRAD(1)=0.
```

Figure 34. Program Listing - AVQUAD, E386RN.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0
      DO 4 I=2,NP
      PSI(I)= PSI(I-1)+ ANG
    4 PRAD(I)= PSI(I)*RAD
      DO 77 I=1,NRAD
      DO 77 J=1,NP
      Q(J,I)=XLO(I)
      DO 77 K=1,NHH
      X=K
   77 Q(J,I)=Q(J,I)+XLM(I,K)*COS(X*PRAD(J))+XMM(I,K)*SIN(X*PRAD(J))
      IF(KEY1.NE.99) GO TO 88
      DO 86 I=1,NRAD
   86 WRITE (6,87) XLO(I),((XLM(I,J),XMM(I,J)),J=1,NHAR)
   87 FORMAT (E25.8/,(2E25.8))
   88 WRITE (6,8) B01,B1,B11,CH,OMG,RBN,RO,(R(I),I=1,NRAD)
    8 FORMAT (4H0B01,E15.6,4H  B1,E15.6,5H  B11,E15.6,7H  CHORD,E15.6,
     1 7H  OMEGA,E15.6,8H  BLADES,F7.0,//25H RADIUS AT START OF TWIST,
     2 E15.6,////30X,21HBLADE SECTION LOADING,///7H RADIUS,10X,1H1,14X,
     3 1H2,14X,1H3,14X,1H4,14X,1H5,14X,1H6,14X,1H7,14X,1H8,/8H AZIMUTH,
     4 2X,8E15.6,//)
      DO 9 I=1,NP
    9 WRITE (6,10) I,PSI(I),(Q(I,K),K=1,NRAD)
   10 FORMAT (I4,F7.1,8E15.6)
      OMG=3.14159265*OMG/30.
      SOS=12.*SOS
      B01=B01*RAD
      B1=B1*RAD
      B11=B11*RAD
      G=G*RAD
C
C     BEGIN MAJOR LOOP ON FIELD POINTS
C
      DO 999 II=1,NFP
      CAPR=CAPRF(II)
      THETA=THETAF(II)
      ALFA=ALFAF(II)
   11 FORMAT (3F12.4)
      WRITE (6,12) CAPR,THETA,ALFA
   12 FORMAT (12H0FIELD POINT,10X,6HRADIUS,E15.6,5X,7HAZIMUTH,E15.6,5X,
     1 9HELEVATION,E15.6,/20X,8HHARMONIC,10X,14HSOUND PRESSURE,15X,
     2 3HSPL)
      CAPR=12.*CAPR
      ALFA= RAD*ALFA
      THETA= RAD*THETA
      DO 999 M=1,NHAR
      DO 990 KK=1,NRAD
      DO 99  JJ=1,NT
      CAPS= SQRT(CAPR*CAPR+R(KK)*R(KK)-2.*CAPR*R(KK)*COS(     ALFA)*
     1 COS(PRAD(JJ)-THETA))
      BETA=B01-G*(R(KK)-RO)+B1*COS( PRAD(JJ)   )+B11*SIN( PRAD(JJ)   )
      SBTA=SIN(BETA)
      CBTA=COS(BETA)
      V= M
      V= V*(RBN*OMG*CAPS/SOS+.5*CH*RBN/R(KK)+RBN* PRAD(JJ))
      IF (KEY3.EQ.99) WRITE (6,9874) CAPS, BETA, V
```

Figure 35. Program Listing - E386RN.

```
1       1         2         3         4         5         6         7         8
........0.........0.........0.........0.........0.........0.........0.........0
 9874 FORMAT (3E25.8)
      TEMP=  M
      V25(JJ)=(Q(JJ,KK)*SIN(.5*TEMP*RBN*CH/R(KK))*(COS(V)/CAPS+(TEMP*RBN
     1 *OMG/SOS)*SIN(V))*(SBTA*COS(ALFA)*SIN(PRAD(JJ)-THETA)+SIN(ALFA) *
     2CBTA)*R(KK))/(TEMP*CAPS*CAPS)
      V25I(JJ)=(Q(JJ,KK)*SIN(.5*TEMP*RBN*CH/R(KK))*(COS(V)*TEMP*RBN*OMG
     1 /SOS-SIN(V)/CAPS)*(SBTA*COS(ALFA)*SIN(PRAD(JJ)-THETA)+SIN(ALFA) *
     2CBTA)*R(KK))/(TEMP*CAPS*CAPS)
   99 CONTINUE
      V25(NP)=V25(1)
      V25I(NP)=V25I(1)
      CALL SIMCOR(NP,PRAD(2),V25 ,AR,IERR)
      IF(IERR .EQ. 0) WRITE(6,8418)
 8418 FORMAT(///25X,23HERROR IN SIMCOR, IERR=0  ///)
      V8(KK)=AR
      CALL SIMCOR(NP,PRAD(2),V25I,AR,IERR)
       IF(IERR .EQ. 0) WRITE(6,8418)
      V8I(KK)=AR
      IF(KEY2.EQ.99) WRITE (6,9876) V8(KK),(V25(I),I=1,NP)
      IF(KEY2.EQ.99) WRITE (6,9876) V8I(KK),(V25I(I),I=1,NP)
 9876 FORMAT (//E25.8/,(5E25.8/))
  990 CONTINUE
      CALL AVQUAD (NRAD,R,V8,PRTAR)
      CALL AVQUAD (NRAD,R,V8I,PRTAI )
      IF (KEY1.EQ.99) WRITE (6,9875)PRTAR,(V8(KK),KK=1,NRAD)
      IF (KEY1.EQ.99) WRITE (6,9875)PRTAI,(V8I(KK),KK=1,NRAD)
 9875 FORMAT (//E25.8,/4E25.8,/4E25.8,//)
      PRTA=(.03582245*CAPR/CH)*SQRT(PRTAR**2+PRTAI**2)
      SPL= 20.*ALOG10(ABS(PRTA/2.9E-9))
      WRITE (6,997) M,PRTA,SPL
  997 FORMAT (25X,I2,5X,2E20.8)
  999 CONTINUE
      B0=GATC1
      B1C=GATC2
      B1S=GATC3
      GAMA=GATC4
      OMEG=GATC5
      RETURN
      END
@IXG  FOR SIMCOR,SIMCOR
      SUBROUTINE SIMCOR (N,H,Y,XINT,IERR)
C     PURPOSE
C
C         TO INTEGRATE A FUNCTION F(X) OVER A RANGE (A,B)
C
C     METHOD
C
C         SIMPSONS RULE WITH A CORRECTION FACTOR INCORPORATED
C          IN THE EQUATION IS USED IF (N-1) IS DIVISIBLE BY
C          BOTH 2 AND 4
C
C         SIMPSONS RULE IS USED WITHOUT THE CORRECTION FACTOR
C          IF (N-1) IS ONLY DIVISIBLE BY 2
C
```

Figure 36. Program Listing - E386RN, SIMCOR.

```
1        1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0   CD COUNT

C          IF (N-1) IS NOT DIVISIBLE BY 2 THIS IMPLIES THAT N
C            IS EVEN AND THIS SUBROUTINE CAN NOT BE USED.
C
C      CALLING SEQUENCE
C
C          CALL SIMCOR (N,H,Y,XINT,IERR)
C
C      DESCRIPTION OF PARAMETERS
C
C            N    -NUMBER OF POINTS THAT ARE TAKEN OVER THE CURVE
C
C            H    -CONSTANT INTERVAL BETWEEN THE POINTS
C
C            Y    -SUPPLIED FUNCTION
C
C            XINT-TOTAL AREA UNDER THE CURVE BETWEEN A AND B
C
C            IERR-ERROR CODE
C                 IERR = 0  (N-1) NOT DIVISIBLE BY 2 THEREFORE N IS EVEN
C                 IERR = 1  (N-1) IS  DIVISIBLE BY 2
C                 IERR = 2  (N-1) IS  DIVISIBLE BY BOTH 2 AND 4
C
C
      DIMENSION Y(1)
      IERR = 0
      K = MOD ((N-1),4) + 1
      IF (K .EQ. 2 .OR. K .EQ. 4) RETURN
      XINT = Y(1) + 4.* Y(N-1) + Y(N)
      N3 = N - 3
      DO 10 I = 2,N3,2
   10 XINT = XINT + 4.* Y(I) + 2.* Y(I+1)
      XINT = H/3.0 * XINT
      IERR = 1
      IF(K .EQ. 3 .OR. N .LT. 9) RETURN
      XINT1= Y(1) + 4.* Y(N-2) + Y(N)
      N6 = N-6
      DO 20 I = 3,N6,4
   20 XINT1= XINT1+ 4.* Y(I) + 2.* Y(I+2)
      XINT1= 2.* H/3. * XINT1
      XINT = XINT + (XINT - XINT1)/15.
      IERR = 2
      RETURN
      END
@IX6  FOR START,START
      SUBROUTINE START
      COMMON /TEMPUS/ TIME,COUNT
      INTEGER COUNT
      DATA COUNT /0/
      CALL RTMINS (TIME)
      COUNT = COUNT + 1
      CALL CLOCK
      RETURN
      END
@IX6  FOR CLOCK,CLOCK
```

Figure 37. Program Listing - SIMCOR, START, CLOCK.

```
1         1         2         3         4         5         6         7         8
.........0.........0.........0.........0.........0.........0.........0.........0    CD COUNT

      SUBROUTINE CLOCK
      COMMON /TEMPUS/ TIME,COUNT
      INTEGER COUNT
      CALL RTMINS (BALLS)
      T    = BALLS - TIME
      WRITE (6,100) COUNT , T
 100  FORMAT (1H255X,18(1H*)/56X,8H*       (I2,8H)       */56X,18H* ELAPSE
     XD TIME = */56X,1H*16X,1H*/56X,2H* F8.4,8H  MIN  */56X,1H*16X,1H*/5
     X6X,18(1H*)//)
      RETURN
      END
@ MAP E676,,OVER
       SEG E676-(*E386RN,*ALPHA)
ALPHA  SEG *RDKU-*UNPACK-*INTERP-*CUE-*INPUTA-*MERGES-*OUTSPL-*DFSRIE
@ ABS OVER,AE676
@ XQT CUR
  OUT Z,2
  TEF Z
  OUT Z,1,3,4
  TEF Z
  TRW Z
  ERS
  IN Z
  TOC
  ERS
  IN Z
  TOC
  TRI Z
```

Figure 38. Program Listing -CLOCK, End.

Unclassified

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| 11. SUPPLEMENTARY NOTES<br>Volume II of 2 volumes | 12. SPONSORING MILITARY ACTIVITY<br>U.S. Army Aviation Materiel Laboratories<br>Fort Eustis, Virginia 23604 |

13. ABSTRACT

A computer program for rotational noise prediction is documented. The program was developed as a part of a study to develop more accurate methods for predicting rotational noise levels under conditions of nonuniform inflow over the rotor disc.

The computer program will calculate the root-mean-square sound pressure level for up to the 10th harmonic of rotor noise at any field point in the near or far field outside of the rotor disc. Noise levels can be calculated either from a rectangular chordwise distribution of pressure or from the measured chordwise distribution. The equations for noise prediction using the arbitrary (measured) chordwise distribution are derived in Volume I of this report. Although this report concentrated on a helicopter rotor, the analytical results are applicable to propellers in general.

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| 14. KEY WORDS | LINK A | | LINK B | | LINK C | |
|---|---|---|---|---|---|---|
| | ROLE | WT | ROLE | WT | ROLE | WT |
| Chordwise Distribution<br>Computer Program<br>Helicopter Rotor Noise<br>Noise Prediction<br>Rotational Noise Levels<br>Rotor noise | | | | | | |